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A TALK ON TEACHING[1]

IN speaking to you to-day upon the subject of teaching, I shall try to present some considerations, suggested by my own experience, in regard to the application of educational principles to our own problems. Much of what I shall say will doubtless be familiar to a body of teachers like yourselves. Yet it is perhaps desirable that even the commonplaces of education be brought before us from time to time; for, though we recognize the abstract principles that should be followed, yet it is only by constant attention to them that we shall succeed in making them the real foundation of our courses of instruction.

Throughout our considerations we must keep in view the aim of the education for which the institute stands. In regard to this there is, I believe, little difference of opinion. The aim is to produce men who have the power to solve the industrial, engineering and scientific problems of the day—men who shall originate and not merely execute. The fundamental question is, then, How shall we develop this power? It is *power* that counts, and not *knowledge*. The ultimate test is what a man can *do*, not what he *knows;* and this is the test we should apply to our students upon the completion of each subject of in-

[1] Given at a conference of members of the instructing staff of the Massachusetts Institute of Technology on March 20, 1908. To Professor H. G. Pearson I desire to express my great indebtedness for his suggestions and assistance in connection with the preparation of this paper for the printer.

struction, and to our graduates at the close of their period of study at the institute.

It is true that a part of the power of a scientific man depends upon his knowledge; and a part of our task as teachers consists in bringing him into permanent possession of those kinds of knowledge which are most essential. In connection with this work of imparting knowledge I ask you to note three kinds of errors into which we are especially apt to fall.

First, it is a common mistake to ply the student with more than he can possibly assimilate. For covering a certain subject we are allowed a limited number of hours; into that time we feel that we must crowd, at any rate, all the obviously important topics. This we make the consideration of prime importance, whereas we should first determine what principles and essential facts can, in the amount of time given, be treated with sufficient thoroughness to enable the student really to comprehend them and make them his own. We must, therefore, constantly examine the courses that we are giving, to see whether they are not overcrowded; and, if they are overcrowded, we must consider how they may be disencumbered, so that the main points may be properly emphasized. *Obiter dicta* have no place in a course of instruction: principles which there is not time to drive home should not be mentioned at all; for they simply confuse the student, by distributing his attention over a larger number of topics than he can possibly assimilate at one time.

The existing conditions make the commission of this error only too easy. There is a constant demand that we give our students a wide variety of information. Not to teach a phase of a subject which may be regarded as important invites criticism and argues incapacity on the part of the teacher. Moreover, in many subjects we are badly off in the matter of text-books: most of our so-called text-books are really treatises and reference books. Would that some competent person would write for a ninety-hour course in chemistry or physics a text-book containing only those facts and principles that can be properly taught in a ninety-hour course! It is this defect which has led so many of the institute professors to prepare notes of their own, the object of which is primarily to emphasize the more fundamental principles of the subject.

Notwithstanding these difficulties, however, it is our clear duty as teachers constantly to endeavor not so much to teach many things as to teach well—not so much to "cover the ground" ourselves, as to make sure that our students go over the course with us. In trying to include too much, we not only sacrifice the opportunity for training, of which I shall speak later, but we accomplish far less than we might even in the matter of imparting knowledge.

The second error of which I would speak is the failure to keep sufficiently in touch with the mind of the student—to appreciate the knowledge which he actually possesses and the degree of development of his mental powers. The unfortunate results of this error are most clearly and frequently observed in lecture courses. The lecturer is apt to look at his task merely from an objective view-point: if he presents his subject clearly and logically, he complacently feels that he has done his part, and that it is the fault of the student if he has failed to profit by it. Yet the real test of the success of a lecture course, as of any other form of instruction, is the amount of benefit that the student actually derives from it; and the teacher must frequently, by some means or other, apply this test, must consider the causes of his incomplete success, and introduce such modifications as seem likely to lead to better results. He must keep in touch

with the student so that he may appreciate his difficulties. This can be done much better in recitations than in lectures, but best of all through personal conferences; and, when conditions make it necessary to give lectures at all, they should be largely supplemented by these means, so that there may be individual contact with the student. It is to be hoped that the plan of regular conferences for which formal provision has already been made in first-year English and mathematics may be soon extended to other subjects; but in the meantime much is being done in this direction in an informal way by many of our best instructors. I wish only to emphasize the idea that such efforts are a well-paying investment of the teacher's time. They not only enable him to assist the individual student in a variety of ways, but they show the teacher the defects of his own methods of presentation and establish a cordial relationship between him and his class.

One important cause of this imperfect adaptation to the mental needs of the student is the lack of correlation between the different subjects of instruction. A teacher ought to know both what the student has already learned in his previous courses and what he will need to know in the later dependent subjects. To this end it is important that instructors should attend exercises in other subjects than their own, examine the text-books used, the notes and problems given out, and the experiments performed. For example, every instructor teaching applied mathematical subjects in the higher years of the various courses should familiarize himself with the new plan of teaching mathematics which has been recently introduced. I believe, in a large school like the institute, the imperfect correlation of the different subjects of instruction is one of the most serious evils, and one which must be met by an increased effort on the part of each instructor to know about the work that is being done in subjects related to his own.

The third difficulty which I would refer to is that which arises from the tendency of the student to learn by memorizing and to do his work in the laboratory mechanically, without thinking. We must not allow ourselves merely to mourn over the fact that the average student won't think if he can help it, or try to justify our failures to get him to do so by reflections on his earlier education. We must face the situation as it actually is, and realize that it is one of the most important parts of our problem to make the student think.

Herbert Spencer is reported to have said, "if he read as much as other people, he would know as little as they." The remark is worth remembering, in spite of its complacency, for the light it throws on the worthlessness of whatever is done without thinking. In science, as in other departments of knowledge, no acquisition is real and permanent which is not won by hard thought. As every teacher knows, a most effective way of making a student think is by constant questioning. He emphasizes a principle by asking questions about its possible applications. He answers one question by asking another, and, if possible, gets the student to put the questions for himself. The good teacher is constantly trying to lead the student on, but he refuses to carry him. In the laboratory and drawing-room, where students tend to work as if their whole purpose were to go through the mechanical operations as rapidly as possible, the successful instructor will be constantly on the alert to check this tendency. He will be with the student at his desk as much as possible, not telling him what to do, but seeing that he understands and plans out his work for himself. Only in matters of manipulation and technique should a distinctly different

plan of instruction be adopted. Here, in order to economize time for more important work, the effort should be made to give the student the necessary manual skill as rapidly as possible, by giving him detailed instruction and showing him by example the little artifices that make the expert manipulator. The engineer, architect or chemist must have a good technique, and we can not afford to neglect it; but one of our problems is to reduce the time needed for its acquirement to its lowest limit.

Summing up now this discussion of the question of imparting knowledge, I would advise especially:

1. That we take care not to include in our courses more than the average student can properly assimilate.

2. That we keep in close touch with the actual knowledge and mental development of the student; that to this end we introduce recitations and invite individual conferences as far as possible; and that we inform ourselves more fully in regard to the work which is done in courses related to our own.

3. That we discourage the habit of memorizing and of working in a thoughtless, mechanical way in the laboratories and drawing-rooms by close personal contact with the student and by appropriate modifications of our courses and of the examinations upon them.

I come now to the other more important and more difficult task of giving the student the mental training upon which the power of handling new undertakings and solving new problems depends. In comparison with this the imparting of knowledge is an insignificant matter. One of our professors has given an apt illustration of the true function of the institute. It should be, he says, a gymnasium where the faculties are exercised and developed, and not a boarding-house where the students are crammed with facts. We want our young men to acquire the power of solving problems; and this, like any other faculty, can only be developed by constant exercise of it. Therefore, we must make problems one of the main features of our courses—problems in the broadest sense, not merely numerical applications of principles. Class-room and drawing-room and laboratory work alike must consist largely in the solution of problems.

This matter of problems seems to me of so much importance that I would like to consider it with you in some detail.

First a few words as to the character of our problems. In the lower schools the questions given out for solution are well called "examples": that is, a teacher does a problem in a certain way, as an example; and the students learn by imitation to do others like it. Of course, for our purposes this kind of problem-solving is of scarcely any value. We must avoid problems which are only pattern-work and those which are simply the substitution of numerical values in formulas. One of our professors who makes problems a large part of his course told me of the student who came to him with the complaint that he couldn't do his problems because each one was different from the others, well showing the kind of problem-work to which he had been accustomed.

There are two classes of problems that are essential to our work—the kind that develop logical thinking or reasoning power and the kind that develop imaginative thinking or the power of planning and originating. For each of these two kinds of problems we should try to make better provision; but the latter kind needs, I believe, special development at the institute. For example, we ought to a greater extent require in our laboratories that the students plan out their own experiments. Students should be told what apparatus is available and what results are wanted, and

then should be left largely to their own ingenuity to produce those results. In each particular line of study there is, moreover, a particular form of problem-work that is appropriate. In engineering subjects it is the design of new structures and of new machines; in the descriptive sciences it is the identification of materials (provided this be done not by tables nor by a set method of procedure, but by the student himself upon the basis of his own knowledge); in English it is the writing of themes; and so on. Each teacher must consider how his subject can be presented so as to afford the largest opportunity for developing the student's reasoning power and creative ability.

Permit me next to say a few words in regard to the importance of independent work in the solving of problems. I believe that only by insisting upon this can anything like the full benefit be secured. In the first place, what we want to do is not to teach the student how to solve certain particular problems, but to train him in original thinking—to solve any kind of problem; and to this end he must do the work himself. Secondly, the line can not be effectively drawn at any other point than that of absolute independence. If one allows working together at all, some students will copy, and a still greater number will get other students to do all the thinking for them. Then, again, if problems form a large part of the term's work, the marks of the term ought to be based principally upon those problems; and this is not fair unless we are able to assure ourselves that the results represent individual work. When this requirement is made of the student, the instructor must be ready to assist him in his difficulties, and must provide definitely for opportunity for consultation; else the conscientious student will waste an undue amount of time before some obstacle which a few minutes' talk with the teacher would remove. It is, I think, very desirable to introduce more extensively the plan, already followed in some subjects, of requiring problems to be done at assigned hours under the guidance of the instructor rather than in outside hours of preparation. I am well aware that there are some advantages in allowing students of the same proficiency to work out their problems together: difficulties are overcome with less loss of time, the principles involved become clearer by discussion, and the work is made more attractive. In exceptional cases, especially with small classes of rather advanced students, who have acquired the true point of view, these advantages may be secured without incurring the evils to which I have referred; but I believe that this is true only in such exceptional cases, and that the difference in the emphasis laid upon independent work by different instructors is a source of demoralization to our students.

The introduction of more problem work naturally carries with it the laying of greater weight on the term work and less on the final examination in determining the record of the student—a thing which is in itself highly desirable. An instructor is sometimes heard to say, "If a man gets the subject in the end, it is all right." That remark shows, I think, that he does not have the true conception of the main purpose of his course, which is not to give a certain amount of knowledge in the subject, but to give a mental training which can only be acquired gradually by persistent effort through the whole term. Indeed, in my own opinion, one of the most effective means of raising the standard of our instruction is the abandonment of final examinations in more of our courses. Thereby not only are the many serious evils of the examination system removed—such as the postponement of serious study till the end of the term, the cramming dur-

ing a short period before the examinations (which is, I believe, wrongly regarded by some instructors who do not appreciate the character of cramming methods as valuable in affording a review and perspective of the whole subject), the attendant nervous strain and injury to health, the evils of tutoring and proctoring—but also because it impresses upon both instructor and student a different educational ideal, that of training the mind rather than storing it with knowledge. Some years ago the faculty took the step of abolishing final examinations in many first- and second-year subjects. I think the time has come when provision should be made by individual instructors and by the faculty for the extension of this plan to many other subjects.

These considerations may be summed up by saying that *problem-solving* is by far the most effective means we have of developing mental power. We must make such work as large as possible a part of our courses, making place for it by the omission of much other material, important though it may be. We must insist on independent work in the solution of problems, but in doing it we must be ready to give assistance to the individual student. Our examinations should be made a test of his power to handle problems connected with the subject rather than a test of his knowledge; and the record we give him should depend mainly on his success in this direction.

Let me pause here to make one remark, lest I should seem to underestimate the success which is already being attained by the teachers of the institute. Any one familiar with our work well knows that what I have said in regard to the relative importance of knowledge and training and the methods of developing mental power is only an expression of the general educational policy of the institute, and that the principles I have discussed have already been extensively put into practise here—probably to a greater extent than in any other large educational institution. I have emphasized these principles only in the hope of impressing each individual instructor more fully with their importance and of encouraging him to aim to base his own teaching upon them as largely as possible.

So far I have considered only that side of our work which relates to the professional training of the engineer or the scientist; but, as we all know, the problem of the institute is not confined to this. It is our function to give a general education in combination with a professional training—to educate the man as well as the engineer. We must constantly bear in mind this twofold aspect of our work, and must be contented to sacrifice in some measure professional attainment in the interest of a broader education. We must aim to develop those qualities which are the result of a liberal training—breadth of view, perspective and soundness of judgment; but we must especially aim to develop character and high ideals. The acquirement of *power* is, as I have said, the intellectual goal towards which we are striving; but we must also keep in view the moral end, which is the cultivation of the spirit which will lead that power to be devoted to some high form of *service*.

Some may perhaps contend that these are not our functions—that our obligations are only on the intellectual side, that the development of the moral, social, esthetic and physical qualities of the student are to be left to outside influences. Such a view is, in my judgment, a seriously mistaken one. It might well be held by the authorities of a graduate school of the purely professional type; but it is quite inconsistent with the conception of the institute as an undergraduate school, whose

primary function is to furnish an effective form of general education. Our students come to us during four years of the most critical period of life, when their habits of thought and ideals of life are being formed; and we must appreciate the seriousness of the trust which is thereby imposed upon us. It is of comparatively little significance whether the student acquires more or less knowledge of mathematics, chemistry, physics or engineering; but it is vitally important that his mental power, his general culture, his character and his ideals be adequately developed. We must, therefore, take care not to interpret our function as teachers too narrowly; but we must each of us improve every opportunity for contributing to the more general and more important result which the institute has in view. The means for attaining this result certainly deserve especial consideration in a talk on teaching. I have already expressed my ideas at some length on the development of mental power. Owing to the limited time remaining, I shall not attempt to discuss the means of developing those important qualities which are summed up in the word "culture"; but I should like to consider with you briefly the still more vital question of what can be done to develop character and high ideals. The indefiniteness of the methods by which this may be accomplished makes the subject a particularly difficult one; but it must not be passed over on this account.

The methods of the institute are especially adapted to develop those habits which go to the formation of character. To meet the demands of our curriculum, the student must be willing to subordinate pleasure to duty; he must work industriously and persistently; he must, too, work rapidly, whereby he comes to appreciate the value of time. Our scientific courses offer, moreover, special opportunities for inculcating habits of accuracy, reliability, clearness of expression, neatness and orderliness; and we must insist that the work be so carried out that these benefits do in fact result. Careless or slovenly work of any kind must be vigorously condemned. We should see that note-books be kept in a neat and orderly manner; that reports be written clearly in good literary form; that in the class-room accuracy of expression be cultivated; that the numerical work connected with problems be accurately performed (nothing like full credit being given when merely "the principle is correct"); and that every reasonable effort be made to verify an experimental result or confirm a conclusion before it is accepted as final. The teacher of any science who says it is not his business to attend to these things does not, in my opinion, understand his business, which is not so much to teach the subject-matter of the science as it is to teach *scientific method* and to cultivate the *scientific spirit*.

Yet the formation of character, important as it is, is by no means the whole of this side of our task. The qualities that make up a good character in the narrower sense are, after all, only "the half-virtues which the world calls best." That the man may be really effective, these must be supplemented by high ideals of service, a strong purpose in life, and a real devotion to it. With respect to means of imparting such ideals, I have only a few thoughts to present.

In the first place, I believe that, to accomplish much in this direction, we must get into personal relations with the student. Thereby many different opportunities of influencing him are opened to us. To begin with, we set him the example of rendering unselfish service to others by giving him individual aid beyond that which our formal obligations in class-room and laboratory demand. Let us make it clear to him

that it is not our primary purpose to "maintain the standard," but that we are personally interested in aiding him to fulfil the established requirements. Up to the end of the course the teacher should consider every student who is doing unsatisfactory work as one of the problems for which he must try to find a solution; and there is, I believe, no better way of securing attention from a student who is neglecting his work or of bringing up to the standard one who is having difficulty with the subject than by showing a personal interest in him. I know that this makes an added demand on the instructor, and that what any one can do in this way is limited; yet it is an aim to be kept in mind and to be striven for. Since at the institute there is one instructor to about seven students, the net result would be very large if each teacher would endeavor to become well acquainted with even this number of his students.

Close contact enables the teacher, too, to influence in a pronounced way the point of view of the student, both with reference to his work at the institute and to his ultimate aims. On occasions when I have talked intimately with students about these matters, I have often felt keenly how much more they need advice about *life* than about chemistry. Such individual conversations furnish also the opportunity of giving the student a broader interest by letting him know of the scientific and professional problems in which ourselves and others are engaged. He thus sees more clearly the future before him, and appreciates better the value of the studies he is pursuing.

Though personal contact is by far the most effective way of exerting these general influences, yet, since it is possible to provide for it only to a limited extent, we must improve the opportunities which our regular courses of instruction afford for securing the desired result.

Some of the ways in which this may be accomplished are to indicate the wide scope of scientific generalizations and the beauty of theoretical explanations, to point out the important technical applications of the principles presented, to describe the considerations and experiments which led to their discovery and the participation of individual scientists in their development, and to indicate some of the numerous problems of the science that still await solution. By thus emphasizing the broad scientific aspects, the practical bearing and the historical and biographical development of our existing knowledge, and by impressing the student with the idea that at present "our science is a drop, our ignorance a sea," we may do much to awaken his interest in knowledge for its own sake and to develop in him broader points of view and higher aims. Especially must the importance of these considerations be borne in mind in subjects that have to be presented by formal lectures. I have already indicated my opinion that as a means of imparting a fundamental knowledge and of giving a mental training the lecture plan is strikingly ineffective, and can be justified from these points of view only on grounds of economy. It does, however, have in non-technical subjects what may be called a cultural function of some importance; for it provides, better than the recitation plan, the opportunity of arousing the broader interests of which I have been speaking.

In conclusion, as a summing up of these considerations, I would urge that we take care not to interpret our work as teachers too literally—that we realize that our task is a much larger one than that of imparting a knowledge of our particular subject, and that it is a broader one even than that of developing the power of dealing with its

problems; that, in fact, the most important and most difficult part of our undertaking consists in cultivating sound habits of thought and work, in developing breadth of interest and good judgment, in molding character, and in creating a high moral purpose.

ARTHUR A. NOYES

SOME PRINCIPLES IN LABORATORY CONSTRUCTION [1]

BY common consent, governing boards of colleges recognize that after a main building has been erected, the next should be a chemical laboratory. The artfulness of teachers of chemistry, perhaps aided by their fumes, has caused their colleagues to exhibit little regret and display but minor envy in the placing of the chemistry department under a separate roof. Limited funds and meager equipment caused the erection of the simplest structures at first. The stupendous development of our commercial prosperity and the more general appreciation of the importance of our science, not only in its applications, but as a factor in stimulating the dormant germ of culture in all men, have caused more generous provisions, with consequent elaboration in construction and equipment of chemical laboratories, entailing the most serious responsibility on the part of the professor in charge.

At the outset, I wish to make it plain that all the ideas put forward here have not been incorporated in our new laboratory. Many have. The reasons why the rest have not is of no interest to you. It is generally recognized that architects, however willing they may be, are of little real value in drawing up plans and specifications for laboratories beyond the exterior and artistic effects, as they are very special in their construction and use, of which the designer is naturally more or less ignorant. Our architect, Mr. George B. Post, however, has shown the greatest consideration and willingness to try to accomplish the ends aimed at. Much that I have to say is based upon a close study of laboratories in this country and in Europe. Many ideas we have put into effect have been secured here and there. A few are original.

[1] Read before the New York Section of the American Chemical Society, March 6, 1908.

The plan of a laboratory should be laid down in accordance with the destiny of the institution, as one may judge by its past and by a careful comparative study of the histories of other institutions, keeping in mind not only the immediate demands, but the probable developments within half a century.

LABORATORY PLAN AND ARCHITECTURAL EFFECTS

In the construction of chemical laboratories, different ideas have to prevail, depending entirely upon the immediate object aimed at by the laboratory. A private laboratory may be constructed along any particular lines desired. Undoubtedly a laboratory for the instruction of students in chemical engineering must be different from that used in instructing students of pharmacy or medicine. Most college laboratories, however, should be constructed with the object of giving a general training in chemistry, and not with the idea of training chemists. That should be incidental, which is not the case with technological institutions, where men are trained particularly in that line. Very special rooms, with particularly special apparatus, fixed and movable, must be provided, depending upon the requirements. This paper is concerned with laboratories for colleges in which general and not specific professional training is the aim.

While it is generally considered that a

chemical laboratory is a workshop, nevertheless a bit of decoration without and within can not fail to gratify the artistic. This is particularly true when a laboratory forms one of a group of buildings constructed according to a particular architectural plan. To cause the chemical laboratory of the College of the City of New York to conform to the architectural features of the rest of the buildings, there have been placed four shields of terra-cotta, about two meters high and one and a half meters wide, on the ends of the building. The two shields in front of the building have two series of alchemistical symbols, indicating the two fields of organic and inorganic chemistry. The other four have the alchemistical symbols indicating the old elements of earth, air, fire and water.

The ground plan of a laboratory should be laid out to secure the greatest amount of light, air and compactness. The plot of land will, of course, influence any decision. Where land is available, it is generally considered by those who have had experience that a building in the shape of the letter E is most satisfactory. The main entrance may well be placed at the front of the central extension, which, being two stories above the basement, may provide space for the main lecture theater. This part of the basement may well be arranged for receiving freight and contain the main or central room for stores.

It is desirable to limit the entrances to the building to two. Near the main entrance should be the director's office and just within this main door should be a small office for the janitor or door-keeper. All communications should enter the laboratory of the building by that means, and the other entrance to the laboratory should be at the rear, or within a court if the building is constructed with a court, and in connection with the main storeroom. This entrance should be used solely for freight purposes.

The width of the building, in my opinion, should at no point be more than sixty feet, except where the lecture theater is located. This will provide an ample corridor of about ten feet and laboratories not too deep for good light throughout, from without. To secure the latter, ceilings should be at least fifteen feet in the clear from the floor. By the use of reinforced concrete for the interior construction, the greatest economy in height of the building may be had.

FLOORING

There has been very much difference of opinion in regard to the kind of material of which to construct flooring for laboratories. Cement is hard; wood gets soggy and is affected by chemicals that are spilled; and asphalt compositions get soft. The heavy desks and hood supports sink and the furniture is thrown out of plumb. A number of different materials have been suggested. In my opinion the best which has been put forward is that which is known as lithoplast, devised by Dr. W. L. Dudley, of Vanderbilt University. It is essentially a paraffined sawdust sand floor, with a magnesia cement. This flooring may be laid in any length and in one piece, and offers many desirable qualities. The baseboard may be made as a part of this floor. There are no cracks. The presence of the sawdust allows of its expansion and contraction with changes of temperature, and the coating of paraffine over it prevents its rotting or napping, which are the objections put forward in opposition to composition floors containing sawdust. It may be tinted, polished, washed or scrubbed. It can be repaired without having cracked joints, and, furthermore, it allows nails and screws to be driven into it in much the same way that wood does.

PLUMBING

It is well recognized now that the plumbing in a laboratory should be exposed. This is accomplished in some cases by having a pipe trough in the floor, covered by a removable trap or grating. This is unsatisfactory, as such a conduit constitutes an open sewer in the floor.

The piping can be best suspended from the ceiling. This need not be in a haphazard manner, presenting an unsightly appearance, but the pipes may be carried in such order as to really constitute a decorative feature of the rooms. In carrying piping from floor to floor, they may be placed in a cupboard in the wall. The face of the cupboards, being held in place by screws, will give ready access in case there be need to inspect or make repairs.

It is advisable to insert a valve in the main which leads to each laboratory. By this means, in case there is need for repair in any one particular laboratory, only that laboratory is thrown out of commission for the time.

As the result of very careful study of the matter of the composition of the waste-pipe, I will say that I regard a high carbon cast iron as being the most satisfactory. This should be dipped in heavy tar which has been heated until it is perfectly fluid. These drains, with a suitable dip and trap, lead to vertical chemical wastes. The latter may well be of glazed earthenware joined with hot tar and surrounded by six inches of concrete. By having several trunk lines, vertical and opening out through the roof, there is little danger of clogging, and corrosion is reduced to a minimum. Obstructions may be removed by dropping a weight, suspended by a cord, through the opening above the roof.

The form of sink connecting with these wastes is not a mere matter of taste. Alberene serves the purpose admirably, but where it is possible, I think the porcelain overflow roll-rim flush sinks should be used. A perforated outlet prevents large solids being washed into the system. A rubber disk, or even a piece of paper, placed over the perforations gives a pneumatic trough of constant level. Should concentrated acid or alkali by chance come into the sink, it may be instantly diluted by turning a valve.

PAINTING

Undoubtedly whitewashed brick walls constitute a very satisfactory finish for a laboratory. White plaster is more attractive, and still more satisfactory is the white plaster which has been given three coats of acid sulphur-proof paint. A combination lithophone and zinc oxide has proved eminently satisfactory. Incidentally it may be stated that a number of paints were tested and found wanting.

All metal ware, which is likely to be exposed to any fumes whatever in the laboratory, should be painted with an acid-proof paint, and that which is underneath the hoods or between the desks may be treated with a black damp-resisting paint. All pipes upon the ceiling, etc., may be covered with the white enamel acid sulphur-proof paint referred to above.

VENTILATION

There are various systems for ventilating buildings in vogue. The one settled upon by our ventilation expert is known as the push and pull system. The air is filtered, drawn over tempering coils by a large motor-driven fan, carried by ducts, and driven in at the upper portion of the room. A fan in the attic pulls the air from the bottom of the rooms through corresponding ducts. Some prefer the pressure system, arguing that the tendency of the air to leak in around the windows is avoided, and,

furthermore, that it facilitates the operation of the hood vents. The hood vents should, in my opinion, be joined up in a separate system with a separate fan. This fan located in the attic will draw the air out at a pressure of about three times as strong as that of the ordinary ventilating system. By providing slides for the hood outlets, or so-called chemical vents, economy in the speed of the motor may be brought about.

Undoubtedly glazed tile is the best material of which to construct the chemical vents. These should be set in hot tar. With buildings constructed of steel and stone, it is not easy, where sizes of the vents are variable, to secure a material properly burned, and it is difficult to hold it in place. We therefore devised a lining for our ducts which we think is satisfactory. The ducts may be cut to pass obstructing steel members or to follow any line that is desired. These ducts are essentially a frame of galvanized iron on the inside of which a lattice work of expanded metal is riveted. Upon this is placed from five eighths to three fourths of an inch of a cement containing some plaster and a sodium silicate composition, which sets to a very rigid mass. It is acted upon very slightly by acids. Of course, hydrofluoric acid attacks it as it does glazed tiling. This is subsequently covered, after thoroughly drying out, with three coats of an acid-proof paint. That which we used was devised by Mr. Maximilian Toch. It may not be uninteresting to give an account of some of the tests to which a preliminary sample duct was subjected before the instructions were given to proceed. A joint was made and was placed in contact with concentrated sodium hydroxide, concentrated ammonium hydroxide, and concentrated hydrochloric, sulphuric and nitric acids. It was slightly affected by the concentrated nitric acid. The coating was furthermore subjected to the vapors of boiling sulphuric acid and to a stream of chlorine. We felt that if it would withstand these reagents it could be safely placed in the building. The interior of these flues may be repainted from time to time by closing all the vents on any one line of the system, except the last one. Atomized acid-proof paint may be swept through the system by having the fan going at full speed. The large duct, five feet in diameter, at the end of the system, should be arranged to collect condensed moisture in a trough from which it may flow into the chemical drain. A man-hole placed at this point allows a cleaner to enter and wash down the walls by means of a hose.

HOODS

The hoods, preferably constructed of wood, should have a stone base slightly inclined to the rear, where an outlet is provided to the chemical drain. We have found that a cup cast of lead containing nine per cent. of antimony is most satisfactory for a connection to the cast-iron chemical drain to which reference has been made. Muthmann has constructed the drain pipes in the new Munich laboratory of this alloy. It is somewhat expensive, but exceedingly attractive, to have the rear of the hoods faced with glass tiling, and the vents made of white porcelain. But if they can do it in Childs's restaurants, I thought we could. Each hood is provided with two vents, one about twelve inches from the floor of the hood, and the other about twelve inches from the top. These vents are provided with sliding porcelain doors so that they may be closed when not in use.

HYDROGEN SULPHIDE

Hydrogen sulphide is delivered throughout the laboratory from a central generating plant in the basement. The Parsons

generator, installed in duplicate, and constructed upon such unusually large dimensions that each apparatus will supply two hundred and fifty outlets operating simultaneously, has been adopted. In this connection the opinion is advanced that the setting aside of a special room where students congregate from all over the building for the use of hydrogen sulphide is unnecessary, and inviting the degeneration of liberty into license. In other words, the "stink room," for large laboratories at least, is a relic of the past. A shelf placed out of doors, in a court, for example, may be provided for the limited number of students, who from time to time must use large quantities of such gases as chlorine.

Lead-lined iron pipe is used for the transporting of hydrogen sulphide and hard rubber cocks are attached to this on the interior of the hoods. No hydrogen sulphide outlets are had except in the hoods. The front windows of the hoods are suspended upon paraffined window cord, which I think is superior to the bronze tape or chains used in some laboratories.

All outlets, except those mentioned, are brought to the front and underneath the floor of the hood. Just within the line of the base of the window-case are bored holes through which the tubing can be led into the hoods. When the tubing is not in all of these holes, the hood is thoroughly ventilated, when closed, by means of these openings.

DISTILLED WATER

The problem of economically providing ample distilled water for a large laboratory is one requiring most careful consideration. It has long been known that condensed boiler steam, even with oil arrestors, fails to be pure enough even for ordinary laboratory work. After securing much advice, the system here outlined was adopted. It may be constructed of any number of units. The water is preheated to remove free ammonia. We have the evaporators in duplicate and twenty condensers. On the try-out, three hundred gallons were produced in an hour. The apparatus is erected in the attic. The principle upon which it depends is that of boiling water with high-pressure steam passing through coils within the evaporators. The evaporators are thirty-nine inches in height and thirty inches in diameter, outside measurement, and contain one hundred and forty feet of extra heavy drawn copper tubing, properly coiled and coated with the best quality of block tin. The outer shell is of fifty-ounce cold-rolled copper; the heads are of same weight and are securely fastened to the sides with three-eighth-inch steel machine bolts. All spuds, nipples and fittings and all inside surfaces coming in contact in any way with the water, are heavily coated with the best quality of pure block tin; all joints are of invisible silver brazings, and all the fittings were sweated and brazed.

The evaporators are fitted with water gauges and cocks, all necessary steam, water and sewer connections, and suitable hand-holes for cleaning. The condensers are six feet in height, composed of two cylinders, the inner cylinder being seven inches in diameter, and the outer cylinder eight inches in diameter. The inside tubes are constructed of twenty-ounce cold-rolled copper, and the outer tubes of twenty-four-ounce cold-rolled copper, block tin coated inside and out, lap seamed. All joints were sweated and soldered with pure block tin. All fittings for water and steam connections are tacked together at regular intervals to prevent buckling with brass blocks, block tin coated. The bottoms of the condensers rest upon and empty directly into a large tin-lined reservoir. Tin-lined iron pipes with tin-lined valves serve

to distribute the water by gravity throughout the building.

OXYGEN AND HYDROGEN

Hoods in which hydrofluoric acid is to be generated, or silica is to be driven off by that acid, should be lined with thin sheet lead. The front windows may be paraffined.

Oxygen and hydrogen can now be conveniently produced electrolytically in suitably placed tanks in which the gases are collected as generated, and stored. Both of these gases can be laid on to the lecture table and in the spectroscopic room. It is also desirable to have the oxygen laid on to the combustion room adjoining the organic laboratory. In this connection it may be stated that a good safety device is necessary to prevent back flash and possible explosions in these pipes. This can be readily accomplished by inserting a device built on the principle of the Davy lamp. About a meter from the final outlet the pipe is increased to double its bore for 250 cm. and then reduced again to its normal size. By inserting a loose roll of copper gauze in this enlarged portion of the pipe the striking back of the flame is avoided.

LECTURE THEATER

The lecture theater should be lighted by skylight and provided with a horizontal black curtain, electrically operated, for darkening the room. On dingy days or in the evenings, this room should be illuminated by diffused light from overhead reflection of electric bulbs hidden along the cornices of the room. If chandelier lighting be used, the Zalinski diffusion reflector made by the Halophane Company should be installed, as the best results are obtained from them.

The esthetic sense has been appealed to in our lecture room and museum by placing in each of these large rooms four plaster cornices. In the lecture room the four give a mythical representation of the realms of solid, liquid, gaseous and unknown forms of matter. In the museum we have the unknown of the past typified, the period of alchemy, the period of chemistry, and the celestial. A magnificent mural painting pleases the eye of one who sits in the grand lecture theater at the Sorbonne in Paris. In our theater, one looks not at the blank walls, but on the left-hand side he sees a framework which carries the names of the accepted chemical elements and the international atomic weights on movable panels. In this manner, as new elements are discovered, the panels may be shifted. As the atomic weights are changed as the result of our increased knowledge and more accurate work, the values can be changed. It may be interesting to call your attention to the fact that provision has not been made for more than one hundred elements, although I am aware that three hundred or more have been suggested.

On the right side of the wall we have the periodic arrangement of the elements in panels. Immediately underneath these panels are chart hangers, ammeters and voltmeters thirty-six inches in diameter (with illuminated scales) for both alternating and direct currents for electric furnace and other demonstrations. Immediately underneath these are glass blackboards with marked squares, the lines of which are not plainly visible at a distance in the room itself, but may be used with ease by the lecturer in plotting curves.

A suitable and separate system of illumination for the blackboards should be provided.

In my opinion, a lecture room should not be constructed to seat more than 250. The size of the room is so great when a larger number is taken care of that those sitting

at the rear, however elevated the seats may be, have difficulty in seeing what actually takes place upon the lecture table. Should the lecture room be larger than that referred to, the experiments must be performed on a very large scale. This we have, in a measure, obviated by placing a reflectoscope on the lecture table, with which experiments on a small scale may be performed, and then thrown upon a screen overhead. In order to accomplish this, the instrument projects various objects upon a mirror which reflects it upon the screen. The screen can be operated to change its angle so that distortion is prevented, as is the practise at Cornell.

In addition to the projection lantern operated on the lecture table, to which reference has been made, a double dissolving lantern is placed at the rear of the room. A convenient method for signaling the operator is had by means of white and red lights, duplicates of which are placed within the movable reading desk on the lecture table so that the operator may signal the lecturer in case there is some temporary delay. Some people prefer a transparent screen placed behind the lecturer with the lantern operated in a room to the rear. We have provided one for such experiments that utilizes the sunlight, which may readily be reflected by a heliostat properly supported without a southern window.

LECTURE TABLE

Many lecture rooms have the lecture tables convex, which, in my opinion, is wrong. Those sitting at the extreme right, for example, see the apparatus head on and can not observe what is really going on. If the table be concave, this is obviated. I do not know any lecture theater in which this system has been adopted. As a matter of economy in room, the straight lecture table perhaps gives the best results.

It will be recognized that the experiments for demonstration should be selected, if possible, from those which show color changes or changes in volume, rather than weight. Pneumatic troughs with glass front and back and rear illumination have given satisfaction in many laboratories. In addition to these we have incorporated a pneumatic trough with mercury, so constructed with an extension pipe 5 cm. in diameter and 800 cm. long, that eudiometer tubes, 2 cm. in diameter, may be raised or lowered to secure an increased or diminished pressure of one atmosphere. The convenience of such an arrangement is obvious.

The size of the lecture table is a matter requiring grave consideration. Some of the most distinguished American lecturers in chemistry think that experiments should be selected to show but one thing at a time. This can not always be done, but necessary apparatus for the experiment, as gas scrubbers, for example, may just as well be placed out of sight and that part of the installation to which the attention of the student is to be particularly directed placed on the table. Despite the clarity of explanation, students often give attention to a fluid flowing into an aspirator bottle, for example, instead of observing the change of color in copper oxide which may be heated in an atmosphere of hydrogen. This principle is so emphasized by some of our most experienced and expert teachers that they allow the apparatus for but one experiment to be placed on the table at a time. That must be removed before the second is begun. An elaborate array of apparatus upon a long table is undoubtedly theatrical in effect and may serve to catch the student's attention at once and hold it throughout the discourse, as he will be afraid of missing a trick. This is not to be depended upon, however, for the next lecture, perhaps upon a more important topic

of even greater interest, requiring but little apparatus, may serve to place the student in the opposite frame of mind.

The earnestness of a lecturer frequently urges him to come close to his hearers. It is remarkable what a difference is produced in that intimate mental association between teacher and student when the broad barrier of the lecture table no longer separates them. If the table be long, the psychological moment often passes in the extended march to get around the end of the table, or the time consumed in retracing one's steps wastes the opportunity to briskly emphasize by a quick reference to a sharp experiment. The desirable features of the various methods referred to may be attained by having a long table, say ten meters in length, so constructed that the two meters of the center are movable, being placed upon ball-bearing rubber-tired wheels. Certain experiments involving distillations, etc., may be in place upon either of the fixed partitions. The center may be removed, giving free movement in and out for the lecturer. By having several of these sections, experiments requiring apparatus which must be built up each time, as for example, some forms of electric furnace, may be performed and temporarily removed without disturbance. One of the movable tables may well be provided with a slab of soapstone or slate.

On the lecture table waste outlets for condenser water may be provided, as well as electric outlets for storage battery (low pressure), direct and alternating currents, switches for the several lighting systems, lantern operators, motors controlling the darkening shades, and numerous cocks for gas, water (cold and hot), steam, compressed air, vacuum, oxygen, hydrogen and hydrogen sulphide. Down-draft vents should be provided in each of the fixed portions of the table. An explosion shield of plate glass is easily lowered into the front of one or both of these tables. By a system of sliding doors, all cocks, drawers, etc., may be closed and locked by one key, thus making a complete cabinet.

Underneath and within sight of the lecturer there should be a clock attached to the electric system of the building. In this connection I should like to say that I think a wall clock visible to the students has no place in the lecture room, or, if it be there, it should be in operation only upon public occasions. In the lecture room the student should give undivided attention to the lecturer and the speaker should be the one to keep an eye upon the time. In the laboratory, there should be a clock within clear sight of every student, as he frequently must regulate the speed of his work by the time at his disposal.

PREPARATION ROOM

The preparation room should be placed preferably at the rear of the lecture desk, although in many laboratories it occupies the space underneath the elevated seats at the rear of the lecture room. A convenient arrangement is to have the preparation room and museum adjoining. In the preparation room it is desirable to have a thoroughly equipped chemical table. A hood should be placed in this room for the convenience of the lecture assistant that he may pursue a research. As he usually gives almost all his time to the preparation of lectures, he should be located right at his work. It is desirable to have in the preparation room, lathes for both metal and wood, an anvil, a large vise, and a carpenter's bench, in addition to the glazed cupboards for storing apparatus used for lecture purposes. There should be a drawing table, also.

In the stock room adjoining the preparation room there should be an annunciator in connection with each laboratory throughout the building and the director's office.

ARRANGEMENT OF ROOMS

It is desirable to arrange the laboratory so that the instruction of a particular kind is done on one floor, as far as possible, or in suites of rooms suitably arranged. We have found it convenient to place the laboratories for general chemistry upon two floors, two of them on the floor adjoining the lecture theater, and four on the floor immediately above. In this manner the presence of a large number of students in the corridors of the remaining portions of the building is avoided. In a college, of necessity, the main instruction is with the first-year students.

Where much demonstration is to be done in the laboratory, it is desirable to have all of the desks in the laboratory facing in one direction, the instructor having a desk upon an elevated stand. This is expensive in room consumption, however. Each desk at least should have a sliding shelf for the student's note-book.

Between each pair of laboratories at the end of the corridor is placed a quiz, or recitation, room. This recitation room will seat the largest number of students which can work in any one laboratory at a time. The principle involved is that essentially outlined in the first paper of this series. The lecture room is for the presentation of general principles, and illustration and elaboration of those principles. This can be done with a large body as well as with a small body of students. When, however, a student must apply some of these principles himself, we regard it wiser to have only a limited number of students working in a laboratory at a time. They are, therefore, divided up into sections, never having a larger number than twenty-eight, and preferably less.

On the third floor from the top, the second-year students may work in analytical chemistry. In addition to four analytical laboratories on this floor, we have an organic laboratory. The organic laboratory has connecting with it a room in which extra precautions have been taken to make it fireproof. This room is used as the bomb room. Opening into the organic laboratory is the combustion room, provided with two tables, fitted with two furnaces each. Suspended above each table is a metallic hood, painted with acid-proof paint, for ventilation purposes. These hoods are connected, however, with the chemical vents, as we get a stronger pull from that fan. On passing through the combustion room, we enter the small balance room, thence back into the organic laboratory.

BALANCE ROOMS

The balance rooms, numbering ten in our building, are arranged without regard to illumination by means of sunlight. We depend entirely upon artificial illumination. In this manner we save much lighting space which is frequently sacrificed for the balance rooms. Furthermore, it has distinctive advantages, because the shadow cast by artificial light is a constant and fixed one, whereas it varies with sunlight, depending upon the time of the day.

Our curriculum requirements lay down as prerequisites for physical, organic, industrial, advanced analytical chemistry, or metallurgy, courses not only in general, but qualitative and quantitative analysis. It will thus be seen that the second-year students all work on one floor. A few third-year students work on the same floor in the organic laboratory. The other third-year students and the senior class work on the ground floor, where we have a suite of rooms for physical chemistry, consisting of a laboratory for physical chemistry, an electrolytic and electric furnace room, and a spectroscopic analysis room. The students who may have elected applied chemistry work in the laboratory bearing that name, and just across the

hall there are three laboratories adjoining one another for water, bacteriological and gas analysis. In the gas analysis room we have found it satisfactory to build the floor of asbestolith composition, which does not crack, so arranged that the baseboard and floor are all one piece and slope slightly to a central cup for the collection of mercury which may fall upon the floor. In the gas analysis room we have also a tin-lined tank holding 100 liters of distilled water, so that gas measurements are made with distilled water of the same temperature as the room.

The advanced analytical laboratory is provided with drying ovens, like those in the Massachusetts Institute of Technology, steam baths, such as one sees in the Harvard laboratory, closed and open hoods. These are constructed of glazed brick, set in cement and pointed up with plaster of Paris. The steam baths are constructed of alberene covered with a series of porcelain rings and are placed opposite plugged vents. Constant water-level contrivances are connected. The water is heated by means of high-pressure steam. In the basement we have a small room adjoining the assay room, which contains grinding machinery, pulverizing and bullion mills, and also types of furnaces, such as wind, down-draft gas, muffle and annealing furnaces.

Except in the case of the laboratories for general chemistry, there is a private laboratory for an instructor adjoining each laboratory in which the students are supposed to pursue a particular course.

In the basement we have a machinery room, containing two filtering plants, a drum for heating water, compressed-air engines, and water and vacuum pumps. In the line of the vacuum piping there is inserted, just before it reaches the pump, a scrubbing apparatus built of cast iron, lined with porcelain. Three of these drums are arranged so that the gases which pass into the vacuum pump are passed through a tower of pumice saturated with concentrated sulphuric acid; another tower containing solid caustic and the third one is placed in front as a safety reservoir. These towers are so arranged that they may be cut out of the system for a short time so they may be cleaned and refilled. This is done from the top. The accumulated liquors may be drawn from the bottom by means of hard rubber cocks.

One small room having a floor drain and connection with the chemical vent is set aside in the basement for the hydrogen sulphide generators. The floors, walls and ceilings are of one piece of asbestolith. This practise is followed in the storage battery room on the same floor.

A constant temperature room is conveniently had by selecting a small inside room in the center of the building and next the ground. It may be lighted by electricity, and, in this way, comparatively slight changes of temperature will be observed during the year.

STORAGE BATTERY

The principle advocated for storage-battery control may best be explained by outlining our system. Forty-eight cells are provided, with a discharge rate of 60 amperes in one hour, and with 120 ampere hours capacity on an 8-hour discharge. The cells are permanently connected as follows: One battery of 8 cells, connected two in series and four in parallel, giving four volts and capable of discharging at the rate of 60 amperes for 8 hours; two batteries of 12 cells each, connected three in series and four in parallel, giving 6 volts and having the same discharging capacity as the 4-volt battery; one battery of 16 cells connected four in series and four in parallel, giving 8 volts and yielding 60 amperes for 8 hours. All the batteries can

be discharged so as to give 240 amperes in one hour.

The four battery systems are connected by cables to five bus bars on the distributing board in the electrolytic room, each bar being provided with 24 distributing sockets. The ends of the batteries are connected in series so that the differences of potential between the bars are, respectively, 4, 6, 6 and 8 volts, and 24 volts between the end bars. By this arrangement any desired voltage from 4 to 24 volts may be obtained. Connections are made from the distributing sockets to any current outlet in any part of the laboratory by means of plugs connected by a flexible cable provided with a fuse. Current is supplied to the user at the voltage and maximum current strength asked for. It is possible to supply about 60 outlets at a time with any voltage up to 24 volts. On disconnecting any allotted cells, the user has to state the approximate number of ampere hours taken from them. A record is kept of this for each battery, and it is thus easy to tell when a battery requires charging. The cells in each battery being used up at the same rate, any single cell is protected from being run down by a careless user, and all cells in a battery are in a comparable state.

The charging leads from the dynamo are led direct to the electrolytic room and connected to two sockets, and the charging connection to any set of cells is made on the distributing board, the battery room only having to be entered to inspect the cells. Current can also be taken direct from the dynamo from these sockets. Two plugs on the distributing board are connected to traveling cables in the battery room, so that any desired number of cells can be permanently assigned for specific purposes, and the condition of each cell investigated. The switchboard is of the simplest construction, yet it offers the most flexible arrangement known to the writer. It is essentially a marble slab supported vertically with brass-lined equidistant holes. A pair of holes leads to each outlet in the laboratory and is numbered. At the bottom are five rows of similar holes leading to the sets of cells in the battery room referred to. The connections are made by two flexible cables.

ELECTRO-ANALYSIS

Knowing of no better arrangement, the room for electro-analysis was copied after that of Professor Edgar F. Smith, of the University of Pennsylvania. There are 14 places containing voltmeters of 50 volts in half-volt divisions, and four voltmeters of 150 volts in half-volt divisions. On each side of these are two ammeters, one reading from 0 to 1 ampere in 100 ampere divisions and the other from 0 to 25 amperes in one fifth ampere divisions. The rheostats for these instruments are of the enamel type, having a total resistance of 172 ohms and divided into 51 steps arranged in geometrical progression.

STOREROOMS

The arrangement of the stock rooms presents interesting problems which are met, as a rule, in many small stores where compactness affords limited opportunity for roominess. As many drawers of various sizes, for different purposes as can be, should be built as part of the cabinet work up to about forty inches from the floor. Upon this can be constructed two kinds of shelves. First, ordinary wooden bottom shelves, preferably movable, for holding chemicals in bottles; second, wire-bottom shelves for holding glassware. Glass tubing and rods, placed on end, are well taken care of by upright partitions about 15 cm. apart and 25 cm. deep. It is desirable to have suspended over the outside of the last men-

tioned, for at least half the distance down, a cloth which prevents the accumulation of dust within the glass tubing. The value of glass for blowing purposes is frequently destroyed by minute particles of dust which accumulate inside the tubes.

In each stock room there should be a large chemical sink, either of alberene or porcelain, preferably the latter, provided with a flush rim. This sink is equipped with cold, hot, and distilled water. Above the sink, peg boards should be placed for the draining of glassware. It is desirable to provide non-spattering nozzles for the cocks over these large sinks.

As alcohol is bought in quantity and without the internal revenue tax, it is necessary to keep careful control over it. We have accomplished this in a most satisfactory manner by securing one of the copper tanks made by the Bramhall, Deane Company. The tank is so constructed, that alcohol is readily pumped into it from the regular containers in which it is shipped. It is provided with a safety valve to prevent excessive pressure being created in case of its being accidentally heated. It is also provided with a glass gauge the entire height, so that the contents may be judged. The cock by which the alcohol is drawn off is made with a lock.

It will be observed from the above that the teaching of one kind of chemistry is localized, and, as one progressively descends, the work of the student becomes more and more specialized along lines of preparatory study which he is to pursue subsequently at a professional school.

Charles Baskerville
College of the City of New York

THE AMERICAN BISON SOCIETY

The president of the society, Dr. William T. Hornaday, has written a letter asking cooperation with the society, in the effort it is now making to complete a fund of $10,000 with which to purchase and establish the Montana National Bison Herd, on the range that has been provided by congress. The ultimate object of this movement is to perpetuate the Bison species and leave it for future generations of Americans. It is hoped that there may be at Ravalli, Montana, in the not fardistant future, a herd of a thousand pure-bred bison, owned by the national government, and self-sustaining, on a fenced range.

At its last session, congress appropriated $40,000 with which to buy from the Flathead Indians twenty square miles of choice grazing grounds, erect a fence around it and dedicate it to use as a national bison range. The society pledged itself to provide the nucleus herd, and present it to the government, as soon as the range is ready. Ten thousand dollars must be obtained with which to discharge this obligation. Up to date subscriptions amounting to $3,102 have been received, and subscriptions to complete the amount required should be sent without delay to Dr. Hornaday, at the Zoological Park, New York City.

THE COMMITTEE OF ONE HUNDRED OF THE AMERICAN ASSOCIATION ON NATIONAL HEALTH

The president of the committee, Professor Irving Fisher, states that President Roosevelt has definitely taken up the program of the committee as part of his administration policy. He intends to incorporate the recommendation in his next message to congress—that the health bureaus of the government be concentrated into a common department, from which the bureaus not consistent with health and education will be removed elsewhere. This will be the first and most important step toward a powerful department whose special interest will be health and education.

The president authorized the announcement of this decision at the recent conference in Washington between the Committee of One Hundred, the American Medical Association, the American Public Health Association, the Conference of State and Provincial Boards of Health, the National Child Labor Committee, the Government Commission on the Organization of Scientific Work, the Public Health and

Marine Hospital Service, the Department of Health of the District of Columbia, the Division of Vital Statistics of the Bureau of the Census and the Surgeon General of the Army, representatives of all of which were present, the only absentees being the Surgeon General of the Navy, the Bureau of Animal Industry and the Bureau of Pure Foods, the representative of which, Dr. Wiley, was detained by a railroad accident. There were eighteen persons present. The conference passed a resolution heartily endorsing the president's action.

Similar resolutions endorsing the work of the Committee of One Hundred were passed on the day previous by the State and Provincial Boards of Health. Later, in Section 6 of the International Tuberculosis Congress, Surgeon General Walter Wyman, of the Public Health and Marine Hospital Service, who was chairman of that section, announced that he was in favor of the president's policy and would cordially cooperate in the endeavor to bring the transfers about.

There is at present no known opposition which should interfere with the passage this fall of legislation to make the necessary transfers. A large number of congressmen have signified their favorable attitude. It is believed that the legislation can be secured provided congressmen are convinced that the leaders in education and in hygiene are earnestly in favor of it.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its autumn session at the Johns Hopkins University, beginning on Tuesday, November 17. On the evening of November 18 there will be a meeting of the committee on policy of the American Association for the Advancement of Science.

THE Right Hon. A. J. Balfour, F.R.S., has been nominated to deliver the Romanes lecture at Oxford University next year. The lecture will, it is reported in the press, be given by President Roosevelt in 1910.

THE Paris Academy of Sciences has elected M. Philippe van Tieghem, the distinguished botanist, as permanent secretary, to succeed the late M. Becquerel.

SIR WILLIAM TURNER, K.C.B., F.R.S., has been elected president of the Royal Society of Edinburgh.

THE following are the officers recommended by the president and council of the Royal Society for election for the year 1908–9: *President*—Sir Archibald Geikie, K.C.B., D.C.L., Sc.D., LL.D. *Treasurer*—Alfred Bray Kempe, M.A., D.C.L. *Secretaries*—Professor Joseph Larmor, D.Sc., D.C.L., LL.D., and Professor John Rose Bradford, M.D., D.Sc. *Foreign Secretary*—Sir William Crookes, D.Sc. *Other Members of Council*—Sir George Howard Darwin, K.C.B.; Professor James Cossar Ewart, M.D.; Sir David Gill, K.C.B.; John Scott Haldane, M.D.; Charles Thomas Heycock, M.A.; Professor Horace Lamb, D.Sc.; Professor Hector Munro Macdonald, M.A.; Frederick Walker Mott, M.D.; the Hon. Charles Algernon Parsons, C.B.; Professor William Henry Perkin, Ph.D.; Professor Edward Bagnall Poulton, D.Sc.; Lieutenant-Colonel David Prain, C.I.E.; Sir Arthur William Rücker, D.Sc.; the Right Hon. Sir James Stirling, LL.D.; Professor Frederick Thomas Trouton, Sc.D., and William Whitaker, B.A.

DR. FELIX ADLER, professor of political ethics at Columbia University, and Dr. W. M. Davis, professor of geology at Harvard University, made their inaugural addresses in the grand hall of the University of Berlin, on November 3.

PROFESSOR WILLIAM Z. RIPLEY, of the department of economics of Harvard University, has left Cambridge for London, where he will deliver on November 13 the annual Huxley lecture before the Royal Anthropological Institute. His subject is "The European Inhabitants of the United States."

THE Anthropological Society of Stockholm has elected Dr. Sven Hedin to honorary membership in the society, and has conferred on him a Wahlberg gold medal.

THE Royal Scottish Geographical Society will confer its gold medal upon Lord Avebury.

DR. B. R. RICKARDS, director of the bacteriological laboratory of the health department of the city of Boston, has resigned to take charge of the laboratory of the State Board of Health at Columbus, O.

MR. J. C. TEMPLE has resigned the position of assistant in soil bacteriology in the North Carolina Agricultural Experiment Station and College to accept a position as soil bacteriologist in the Georgia Experiment Station.

DR. A. J. EVANS, F.R.S., will resign the keepership of the Ashmolean Museum, Oxford, at the end of this year.

THE American Philosophical Society has appointed Dr. Henry F. Osborn, of New York, as its representative at the commemoration of the hundredth anniversary of Charles Darwin's birth, and the fiftieth anniversary of the publication of the "Origin of Species," to be held at Cambridge, under the auspices of the university, on June 22–24, 1909. It has appointed Dr. William Trelease, of St. Louis, to represent it at the inauguration of Albert Ross Hill, LL.D., as president of the University of Missouri, on December 10 and 11, 1908.

DR. ADOLPH HEMPEL, '95, Illinois, plant pathologist and entomologist and professor in the Agricultural College at Sao Paulo, Brazil, will represent the University of Illinois at the first Pan-American scientific congress to be held at Santiago, Chili, commencing December 25.

PROFESSOR CHARLES D. MARX, of the department of civil engineering of Leland Stanford Junior University, has been engaged by the supervisors of San Francisco to report on the Hetch-Hetchy water project, now under consideration by the city.

PROFESSOR R. J. H. DELOACH, professor of cotton industry in the State College of Agriculture at Athens, Ga., has been made a member of the committee on Cotton Breeding of the American Breeders' Association.

PROFESSOR BESSEY, of the University of Nebraska, delivered the annual "college day" address on the twenty-first of October at the Iowa State College, Ames, Iowa, this being the fortieth anniversary of the opening of the college. The subject of the address, which is soon to be published in *The Alumnus,* was "Laying the Foundations."

THE second lecture of the Harvey Society course, delivered by Dr. William G. MacCallum, of Johns Hopkins University, at the New York Academy of Medicine, on November 7, was on the subject of "Fever."

W. FALTA, M.D., docent of internal medicine in the University of Vienna, gave a lecture on "The Relations between Diseases that are caused by Disturbances of Internal Secretions," at the Harvard Medical School, on November 3.

DR. ALEXIS CARREL, of the Rockefeller Institute for Medical Research, New York, read a paper on "Recent Studies in Transplantation of Organs in Animals," at the meeting of the American Philosophical Society, Philadelphia, on November 6.

RAEMER REX RENSHAW, instructor in chemistry in Wesleyan University, gave an illustrated lecture on "Industrial Alcohol," before the Middletown Scientific Association on November 10.

A MEMORIAL service at the University of Kansas in honor of the late Dr. Francis Huntington Snow, chancellor of the university from 1889 to 1901, and professor in the department of natural science since 1866, was held on November 10. Mr. James Willis Gleed delivered an address on behalf of the alumni, and Dean Green for the faculty. Dr. S. W. Williston, of the University of Chicago, who for many years was a colaborer with Dr. Snow in the work of building up the entomological and paleontological departments of the university to their present high standards, gave an account of Dr. Snow's work for the advancement of science. Col. H. L. Moore, of Lawrence, spoke for the citizens of the town on "Dr. Snow as a Private Citizen."

AT the meeting commemorative of Dr. Daniel C. Gilman, late president of Johns Hopkins University, held last Sunday afternoon in McCoy Hall, addresses were delivered by President Remsen, Professors Gildersleeve

and Welch, and the Hon. Charles J. Bonaparte, United States attorney-general.

DR. ALTHOFF, who a year ago retired from the directorship of the ministry in charge of the Prussian universities, and eminent for his services to higher education, has died at the age of sixty-nine years.

THE deaths are also announced of Professor Paul Henning, curator of the Royal Botanical Museum, at Berlin; of Dr. Cuthbert Collingwood, at the age of eighty-two, the author of "Rambles of a Naturalist in the China Seas," and of various scientific papers; of M. Gustave Canet, past president of the Institution of Civil Engineers, of France, and one of the founders of the French Association for the Advancement of Science; and of Mr. Henry Chapman, known for his work on the development of the application of machine tools actuated by hydraulic power, the perfecting of torpedo machinery, and with air compressors.

THE Swedish Medical Society of Stockholm celebrated the hundredth anniversary of its foundation on October 25.

AT the Baltimore meeting of the American Nature Study Society, December 29–31, there will be a session devoted to the relation of nature study and agriculture in elementary and ungraded rural schools, and another on relation of nature study to high-school science. Teachers and others who have suggestions to contribute are invited to send statements of their views and experience to the secretary of the society, Professor M. A. Bigelow, Teachers College, New York City.

PROFESSOR WILLIAM JAMES is now giving at Harvard University the course of eight lectures that he gave last spring at Oxford University on the Hibbert lectureship. The title of the lectures is "The General Situation in Philosophy," and the subjects of the several lectures are as follows:

November 6—The Types of Philosophic Thinking.

November 9—Monistic Idealism.

November 13—On Hegel.

November 16—On Fechner.

November 20—The Compounding of Consciousness.

November 23—Bergson's Critique of Intellectualism.

November 27—The Continuity of Experiences.

November 30—A Pluralistic Universe.

JESUP lectures will be delivered, under the auspices of Columbia University, at the American Museum of Natural History, on Wednesday evenings at eight o'clock, by Professor Richard C. Maclaurin, professor of mathematical physics. Professor Maclaurin's general subject will be "Light." The lectures, ten in number, will begin November 18.

HEWITT lectures, which are similarly conducted by the university at Cooper Union, will be given by Dr. William J. Gies on Monday evenings, beginning February 8. Dr. Gies, who is professor of biological chemistry at the College of Physicians and Surgeons, is arranging a series of experimental demonstrations to accompany his eight lectures, the subject of which will be "The Chemistry of Nutrition."

THE Shaler memorial expedition to Brazil, by whose provisions Professor Woodworth and several other members of the Harvard department of geology are now working in South America, has been the subject of a conference in the lecture room of the mineralogical museum. Professor R. DeCourtney Ward, who spent part of his summer in the country with Professor Woodworth, spoke of the weather and climate of Brazil, and Mr. Winthrop P. Haynes described the geology of eastern Brazil.

ACCORDING to foreign exchanges Professor Ehlers, of Copenhagen, well known as an authority on leprosy, is now in Paris with the view of organizing a scientific expedition to the Danish West Indies, which comprise the islands of St. Thomas, St. John and Santa Cruz. The object of the expedition is said to be to endeavor to determine the part played by blood-sucking insects, especially fleas and bugs, in the dissemination of leprosy. If the negotiations for the purpose come to a practical issue the expedition will consist of an equal number of Danish and French workers.

THE German Meteorological Society offers a prize of 3,000 Marks for the best treatment of meteorological observations obtained in the international ascents. The paper must be

presented anonymously in German, English or French, not later than the end of 1911, to the secretary of the society, Professor G. Hellmann, Berlin W., 56. Shinkelplaz 6.

The exhibit on the ground floor of the American Museum of Natural History illustrating the solar system has been altered so as to be more comprehensive and instructive. The sun is now represented by an illuminated globe three inches in diameter, which brings the orbit of the earth just within the foyer. The foyer, therefore, now contains the whole of the orbits of Mercury, Venus and the earth and part of that of Mars, while the adjoining exhibition halls contain the remainder of the orbits of Mars and parts of those of Jupiter and Saturn. The orbits are represented by circles of wire on which the days and months are indicated and along which the planets, shown as lights of proper size, are moved from day to day in correct position.

The production of quicksilver in the United States in 1907, as shown by confidential returns to the United States Geological Survey from every producing mine in the country, amounted to 21,567 flasks of 75 pounds each, and was valued at $828,931, the figures showing a decrease, when compared with those for 1906, of 4,671 flasks in quantity and of $129,703 in value. A detailed report on the industry, prepared by H. D. McCaskey, geologist of the survey, has been published in an advance chapter from "Mineral Resources of the United States, Calendar Year 1907." An output of quicksilver was reported from but three states in 1907—California, Texas and Utah—and the single producer in Utah reported no production for the last seven months of the year. A small amount was reported from Oregon in 1906, but none at all in 1907. In California, which furnishes about 80 per cent. of the domestic production, the industry was not in a very flourishing condition during the year. The returns from the state show a decrease of 2,879 flasks in quantity and of $68,264 in value from the production of 1906—an output of 17,431 flasks, valued at $662,544, having been reported in the later year as compared with 20,310 flasks, valued at $730,808, in the earlier. The decrease in the hydraulic mining of gold, formerly so important an industry in California, the decreased amount of gold and silver recovered by amalgamation process alone, and the increased tendency to ship ores of the precious metals to smelters have all tended to reduce the local demand for quicksilver. Statistics of world production of quicksilver for 1907 are not yet available, but a comparison of the figures for quantities produced in foreign countries in 1906 with those for the United States in that year shows that this country ranked second among the quicksilver producers in that year, Spain having first place. Austria held third place, Italy fourth and Russia fifth. Practically all of the quicksilver product of Spain comes from the famous old mines of Almaden, where about 4,000 men are employed. It is probable that these mines alone contain sufficient reserve ore to enable them to dominate the world's market.

In May, 1906, Dr. Sheffield Neave was asked by the Tanganyika Concessions, Limited, on behalf of that company, of the Union Minière, and of the Benguella Railway Company, to ascertain, in respect of the mining area of Katanga, the distribution of the various species of tsetse and other biting flies, to study the distribution of sleeping sickness should it be found to exist, and to investigate the blood of the population in any infected area, to make research generally in respect of the disease in the concession and its neighborhood, and to report and advise as to what measures should be taken in respect thereto. The author has now narrated his experiences in a paper entitled Portions of Report on Work of Katanga Medical Commission, 1906, 1907, 1908. An abstract in *The British Medical Journal* states that a considerable portion of the time was spent ascertaining the distribution of *Glossina palpalis*, but other research work, when time permitted, was carried out. Dr. Neave found that the most typical form of enlarged glands containing trypanosomes was that which included the following qualities: (1) A symmetrical enlargement on both sides; (2) chain formation as opposed to single

glands; (3) a resilient sensation given on palpation somewhat resembling an elastic distended airball; (4) size, about that of a hazel nut, a gland giving the idea of being something a little less than half an inch when taken up in the ordinary way between thumb and finger under the skin. In 1,327 palpations the percentage of enlarged glands from endemically-infected districts was found to be 62.4 per cent., as compared with 3,972 palpations, with a percentage of 39.2, where the disease did not exist. This latter figure clearly shows that enlarged glands must not always be considered proof of sleeping sickness. The letter from Mr. Williams to Dr. Neave indicates that the disease is not so severe and widespread in Katanga as was at first thought.

THE RESIGNATION OF PRESIDENT ELIOT

AT a meeting of the president and fellows of Harvard College, on October 26, President Eliot presented the following letter:

TO THE PRESIDENT AND FELLOWS OF HARVARD COLLEGE:

Gentlemen: I hereby resign the office of president of Harvard University, the resignation to take effect at your convenience, but not later than May 19th, 1909.

The president's intimate association with the other members of the corporation in common service to the university is one of the most precious privileges of his highly privileged office. For this association with the fifteen friends who are dead, and the seven who are living, I shall always be profoundly grateful.

Congratulating you on your labors and satisfactions in the past, and on the sure prospect of greater labors and satisfactions to come, I am, with high respect,

Your friend and servant,

CHARLES W. ELIOT

10 October, 1908

Whereupon it was

Voted, That the president's resignation be regretfully accepted, to take effect May 19, 1909.

UNIVERSITY AND EDUCATIONAL NEWS

THE Iowa State College is just completing a new hall of agriculture of white stone construction, over two hundred feet in length, at a cost of approximately three hundred thousand dollars.

THE cornerstone of the new agricultural hall of the University of Missouri was laid recently. The building will cost $100,000. Among the speakers were B. H. Bonfoeyn, of Unionville, Mo., a curator of the university; Norman J. Colman, commissioner of agriculture under President Cleveland; Dr. B. T. Galloway, an alumnus, now chief of the division of vegetable pathology of the Department of Agriculture; Dr. A. Ross Hill, president of the university; Dr. R. H. Jesse, late president, and Henry J. Waters, dean of the college of agriculture.

THE University of Kansas has completed the equipment of a special laboratory for water analysis in connection with the state water survey. Special problems of public water supply, sewage and industrial waste will be taken up this winter. The work for the U. S. Geological Survey in analyzing the waters of rivers and streams in the state has been completed.

WITH the organization of the department of mining engineering in charge of Professor E. C. Holden, a graduate of the Columbia School of Mines and a practical mining engineer, the college of engineering of the University of Wisconsin is giving this fall for the first time a complete course in the practical details of mining. During the first semester the students are given work in excavation, explosives, blasting and tunneling, which will be followed by other courses in boring and shaft sinking. In the second semester the subjects of prospecting, the development and the exploitation of mines will be studied, and the students from the senior class will be given additional courses in the design of haulage, hoisting, pumping and ventilating systems for mining plants. Plans are now being made for the further equipment of the department with machines and apparatus for demonstration and laboratory work. The main portion of the equipment will be centered in an ore dressing laboratory, which will probably occupy the building formerly occupied by the university heating plant. Some small additions of machinery have already been secured, and it is expected

that within a year a well-equipped ore dressing laboratory will be at the service of the students of mining engineering.

The widow of the Bavarian Surgeon-General Lotzbeck has given the sum of 20,000 Marks to endow a scholarship for medical students.

Professor John T. Hayford has accepted the directorship of the new school of engineering which Northwestern University will inaugurate in 1909. He will terminate his connection with the U. S. Coast and Geodetic Survey, and take up his duties at Evanston in the summer of 1909.

Mr. R. E. Stone has resigned an instructorship in botany at the Alabama Polytechnic Institute to accept a professorship of agricultural botany in the University of Nebraska.

Dr. Cyrus W. Field has resigned his position as assistant director of the research laboratory of the Department of Health, New York City, to accept the position of professor of pathology and bacteriology in the medical department of the University of Louisville.

Dr. Arnold Jacobi, director of the Natural History Museum in Dresden, has been appointed professor of zoology in the technical high school of that city.

Dr. Max Reithoffer has been appointed professor of electrical engineering at Vienna.

Dr. Alexander Supan, head of the Perthes Geographical Institute and editor of *Petermann's Mitteilungen,* has been made professor of geography at Breslau.

DISCUSSION AND CORRESPONDENCE

THE GARTER SNAKES OF NORTH AMERICA

To the Editor of Science: The U. S. National Museum has recently published (Bulletin 61, June 24, 1908) an important and very interesting account of the garter snakes of North America, by Mr. Alexander G. Ruthven. On reading the discussion of the variability in color and scutellation, I was struck by the absence of any reference to Sperry's earlier work along the same line. Again on reading the account of *butleri,* I was surprised to find no reference to Whittaker's very detailed study of the connection between *butleri* and *brachystoma.* These omissions led me to examine Mr. Ruthven's bibliography, with the rather surprising result of finding the three following papers lacking:

F. N. Notestein, 1906. The Ophidia of Michigan with an Analytical Key. Seventh Rep. Mich. Acad. Sci., pp. 111–125.

W. L. Sperry, 1905. Variation in the Common Garter-Snake (Thamnophis sirtalis). Fifth Rep. Mich. Acad. Sci., pp. 175–179.

C. C. Whittaker, 1906. The Status of Eutænia brachystoma. Seventh Rep. Mich. Acad. Sci., pp. 88–92.

Now, of course, it is very possible that I have entirely misunderstood the scope of Mr. Ruthven's bibliography, and that he only intends to include papers to which he refers in his text. He certainly knew of these three papers, as he has been a member of the Michigan Academy of Science since the spring of 1904.

But if his bibliography is complete so far as his own text-references go, I still do not understand why no reference is made to Sperry's and Whittaker's papers. So far as I know, Sperry's paper was the first discussion of variability in a garter snake, based on a large amount of material from a single locality. Some of the conclusions are of such importance that they ought to have been discussed by Mr. Ruthven. Concerning *butleri,* Mr. Ruthven says he has "already expressed the opinion" that Cope's specimen of "*brachystoma*" is identical with *butleri.* As Mr. Ruthven's opinion was not published until March, 1906, and Whittaker's elaborate discussion of the point was presented to the Michigan Academy, at Ann Arbor, in March, 1905, it would seem as though some mention of Whittaker's conclusions ought to have been made by Mr. Ruthven.

Very possibly it may be said that neither Sperry's nor Whittaker's paper was of sufficient importance to warrant notice, but to this I can not agree, and the purpose of this communication is to call attention to what seems to me an unfair neglect of earlier workers.

Hubert Lyman Clark

A NEW LOCALITY FOR MIOCENE MAMMALS

SOME time ago Mr. William Stein, one of my students, brought me a fragment of the lower jaw of some equine, containing two teeth, excellently preserved. The specimen was found at his father's ranch at Troublesome, in Middle Park Colorado, in the course of making a well. It was about thirty feet from the surface, in red soil. As no Miocene beds have ever been reported from this region, the discovery is a remarkable one. Photographs of the specimen (three aspects) were made and sent to Dr. J. W. Gidley, of the National Museum. He very kindly replied that it was difficult to determine the species, but the characters shown seemed to place it rather definitely in the genus *Parahippus*. The horizon was Middle or Upper Miocene. Dr. W. D. Matthew also kindly examined the photographs, and thought the animal was correctly referred to *Parahippus*, and of Miocene age.

Mr. S. A. Rohwer made a trip to Troublesome, in order to search for further materials, but although he carefully examined all the surrounding region, he could not find any fossils. It seems probable that the deposit is quite local, and it may be that only extensive excavations at the Stein ranch will uncover the fossiliferous beds.

T. D. A. COCKERELL
UNIVERSITY OF COLORADO

EDUCATION AND THE TRADES

I READ with much interest "The High School Course," by President David Starr Jordan in *The Popular Science Monthly* for July. While the tenor and purpose of the article as a whole are commendable, as progressive and liberal, one sentence contained therein shows that President Jordan is not unlike the orthodox ministers and church members, who pride themselves upon their broadmindedness in having renounced the fire and brimstone hell, although they still hold fast to the devil—or who would look after the bad people, pray?

The sentence to which I refer is the following:

> But the purpose of this training must be intellectual, not to teach a trade, and only secondarily to fit for engineering courses of the universities.

Not to teach a trade! Why not lift the trades out of the gutter? and acknowledge them to be suitable, yea, fertile fields for intellectual activity?

President Jordan says:

> The development of manual training of some sort for all boys and girls will represent the greatest immediate forward step in secondary education.

Why? Simply because it is an approach toward the proper recognition and appreciation of that which is practical and useful.

In noting the great hue and cry which has gone over the country against child labor, I have often thought that these children who labor are not much more sinned against than the school children who are shut up in school rooms day after day and forced to study things which seem wholly foreign to their lives. They are obliged to sacrifice their most receptive years to the old traditional idea of education which consisted in the acquisition of so-called *intellectual knowledge;* of knowledge which was out of the reach of the working people, held aloft and kept free from contamination with the vulgar trades; knowledge which could never be degraded by use, in earning a living. Is it not high time that we break away from these shackles of tradition, and no longer wrong the trades by ostracizing them and considering the mastery of a trade something separate and apart from an intellectual pursuit?

A trade is defined as:

> An occupation, especially mechanical employment, as distinguished from the "*liberal arts*"—the learned professions, and agriculture. As, we speak of the trade of a smith, of a carpenter, or a mason, but, not now of the trade of a farmer, or a lawyer, or a physician.

This *now,* in the definition, shows that the farmer, lawyer and physician used to belong among the "tradespeople."

The intellectual boundaries will not suffer if the trades enter in. The old "no-trespassing" signs must come down, and the *trade-idea* must be elevated and placed upon a par with the so-called liberal arts.

It harks back to the old-world ideas of nobility and caste to insist upon a separation of the cultivation of the intellect, and the use that may be made of such cultivation.

Why should it be unworthy or undignified, and devoid of intellectual profit, to teach carpentering and plumbing, cooking and dressmaking, etc., instead of *manual training*, and *domestic science?* Is it not a foolish remnant of old-world pride, a relict of false aristocracy to which we feel we must cling, for fear the old world may sneer at our democracy?

A president of a university once said to me:

> If any one in speaking of our department of domestic science should call it a cooking school, just take a club to him, in my name.

In discussing some elaborately concocted dish, with a graduate of this department of domestic science, I remarked that too much time and labor were consumed in its preparation to justify its place in a menu, and she replied:

> O, I just learned how to make it in order to be able to teach in a domestic science department in some college, you know!

So it seems that our manual training is more or less entangled with the prevailing ideas about intellectuality and—the trades.

It is considered actually dangerous to open our curricula doors to the great arena of practicability, for fear of the over-cultivation of the material nature at the expense of the *inner life*. Let me quote from a recent university commencement address:

> Educational science regards the development of the inner life as the true course, and yet it is almost entirely neglected in both common school and college. A material education is the one sought, and though this is against all philosophy, it is kept up by the clamor and clatter of the world's perverted ideals. The true doctrine is preached in the halls of education and finds eloquent advocacy in school literature, but when it comes to real experience it recoils before the money-making, pleasure-getting and fame-achieving anxieties of the schools.
>
> The energy of the school purpose is diverted almost wholly to how to make a living, while how to live, which is the greater quest, is quite neglected.

In this age of the world it seems utter folly to philosophize about the outer and the inner life, as if they were two separate and distinct entities.

Imagine the world intent upon the cultivation of the inner life—having renounced its worldly zeal in making a material living! Commerce would go to sleep and civilization would drop back into barbarism. The consensus of opinion of the thinking world today is that the status of commercialism in any country is an index to the condition of civilization in that country. Every kind of labor may be the means of the cultivation of the outer and the inner life, but the inner life will never be lifted to a higher, spiritual plane by decrying what is popularly called the money-getting-sin. The inner life can only develop as the outer life prepares the way; the two are bound together and no philosophy can rend them asunder.

Only by teaching honestly what the world needs, and can use, may the schools accomplish their lofty aims.

It is a slow and wasteful method to try to help on the progress of general education by forcing an overflow of the *liberal arts* down into the trades, by way of the public schools. The better way would be to help the trades themselves to climb to more and more increased proficiency by the aid of the public schools and higher institutions of learning.

Stella V. Kellerman

PROVINCIAL MUSEUMS

Professor C. C. Nutting has recently written a very suggestive paper entitled "The Function of the Provincial Museum,"[1] which the writer has read with great interest. On page 169 the following statement occurs, which requires emendation:

> One has to look in vain for such a museum in our central states, the nearest approach to it being our own museum at Davenport. But the time is coming when such institutions will rank in importance with either of the other classes enumerated above.[2]

[1] *Proc. Daven. Acad. Sci.*, X., p. 167.

[2] Referring to the University and Metropolitan museums.

It is possible that Professor Nutting excluded from his consideration all museums which were wholly or partly supported by public funds, but the inference drawn from the paragraph quoted above is that there are no museums in the central states which are following along the lines indicated in his paper. There are at least two museums which should be classed as provincial museums which are now doing (and have been for some time past) the work outlined in Professor Nutting's paper, viz., the Public Museum of Milwaukee and the Chicago Academy of Sciences.

Both of the institutions mentioned are making extensive local collections, the exhibits are arranged and labeled with special reference to the education of the public, loans of material are made to the schools and large study collections are being acquired for research work. Free public lectures are maintained in the latter institution.

This statement is made with no desire to criticize Professor Nutting's very excellent paper, but simply to rectify a manifestly misleading statement, the inaccuracy of which doubtless escaped the notice of the author.

FRANK C. BAKER

MILK PROTEINS

TO THE EDITOR OF SCIENCE: The October number of the *Journal of Biological Chemistry* contained an article entitled "Milk Proteins," by Geo. A. Olson, and written as a "Contribution from the Agricultural Chemical Laboratory of the University of Wisconsin." It is generally assumed that when articles appear under the above caption they have received the sanction of those in charge of the laboratory from which they emanate. I desire to state that in this case Mr. Olson is entirely responsible for the material of his article and that those in charge of the laboratory assume no responsibility whatever for the deductions therein stated. I trust you will find a place in an early issue of SCIENCE for this note.

E. B. HART

UNIVERSITY OF WISCONSIN,
November 2, 1908

QUOTATIONS

THE RETIREMENT OF PRESIDENT ELIOT

THE announcement that President Eliot is to retire next March will come as a shock to thousands of persons who have never even seen University Hall. The country has come to look upon him as a great natural force, like the Gulf Stream, unwearied by the flight of time, unworn by incessant activity. Yet at the age of seventy-five even the strongest man is entitled to throw off some of his burdens. This is not the occasion, however, to review President Eliot's career as a whole; for he has, we trust, years of beneficent toil still ahead of him; our purpose is merely to touch on a few of the aspects of his administration at Harvard, and the causes which have made his the most notable career in the history of American education.

President Eliot would be the first to point out that he was fortunate in both the place and time of his labors. Harvard was the oldest college in the United States; it had the longest tradition of culture; it was at the center of the most highly educated and thoroughly civilized part of the union. Then, too, he assumed the presidency in 1869, just at the beginning of that period of enormous agricultural and industrial expansion which followed the civil war. America was growing rich rapidly, and Harvard has shared this prosperity. Other colleges have also had their part in this general advancement: why has Harvard taken the lead? Why is it the foremost university in America to-day? There can be but one answer: Because President Eliot has displayed in extraordinary measure the qualities of a great leader. When the graduates of Harvard addressed him in a formal letter on his seventieth birthday, they said: "With prophetic insight you anticipated the movements of thought and life; your face was toward the coming day." This is perhaps the best definition of a leader—that he is a man who sees in the long march of events the coming of the inevitable, and sets himself to hasten it.

President Eliot foresaw the coming of the elective system. It had, indeed, already come, here and there, in a limited way. Many edu-

cators, however, were not aware of the fact; others caught half-glimpses of the movement and stubbornly—shall we say blindly?—resisted it. He perceived the impending revolution and unhesitatingly cast his influence on the side of the new régime. It was evident that, with the development of scientific research in many branches, with the quickening interest in historical studies and economics, in the fine arts, and in modern languages—that under these circumstances the old hard and fast curriculum was bound to break down; that it had broken down. No college could pretend to minister to the intellectual needs of mankind which confined its students to the narrow round of the classics, mathematics, cut-and-dried philosophy, and a smattering of physics and chemistry. The new wine was bursting the old bottles. President Eliot dared greatly. Under a storm of criticism he boldly converted Harvard into an experimental laboratory for the application of the elective system. That experiment has not yet ended. We may not have mastered all the principles involved; we are still overwhelmed by the mass of details to be coordinated and subordinated. But whatever final results the centuries may bring, we can say now that President Eliot achieved a success which astonished his supporters and confounded his opponents.

The elective system is based on the theory that the best educational product is to be obtained only when student and teacher enjoy the widest intellectual freedom; and to this theory President Eliot has adhered with unswerving consistency. Indeed, he is often accused of pushing it to extremes. The student is allowed unrestricted range in the choice of courses; the professor's academic freedom has, as President Eliot himself once expressed it, been subject to only two limitations, "those of courtesy and honor." The president, too, has followed a liberal principle in picking his faculty. He has never shown that suspicion or dread of unusual intelligence, that predilection for mediocrity, which marks some of our heads of universities. He has selected the ablest men he could find, whether graduates of Harvard or not, and Harvard has thus escaped the blight of inbreeding which two or three decades ago afflicted Yale so severely. And all these policies have been carried out with wonderful executive skill—with unexampled grasp of detail, with foresight, patience, steadiness and tolerance.

To find a man who can fill his place is, of course, impossible. His attention to public questions and his utterances on such subjects as labor and its rights have made him the foremost private citizen of the United States. But it will take a long time for the next president of Harvard to establish such a reputation. Even the administrative work will have to be rearranged; for the giants who can lift the load to which his shoulders have grown accustomed are few. Nor are Harvard's problems all solved. The practical application of the elective system is full of difficulties. The system has been abused at Harvard and elsewhere. Small institutions of limited resources, ambitious to present an imposing list of courses in the catalogue, have sacrificed the instruction in the old studies with well developed disciplines, in order to spread the teaching thin over a broad field. If Harvard has been able to avoid this form of enfeeblement and demoralization, it has had other forms to contend with. Committees of the faculty are still trying to devise means by which students shall not divide and dissipate their energies in too many directions, or shall not slip through college on "soft" courses and practically avoid all study. These, however, are minor matters; for if Harvard can maintain a distinguished faculty, can make the conditions of life and teaching at Cambridge so attractive as to draw to its service the finest minds and characters in America, the rest will be comparatively easy. Thus President Eliot's successor can, as the letter of resignation puts it, face "the sure prospect of greater labors and satisfactions to come."—New York *Evening Post.*

SCIENTIFIC BOOKS

Marine Engineering. By Engineer-Commander A. E. TOMPKINS, Royal Navy, Late Instructor in Steam and Marine Engineering, Machine Construction, etc., at the Royal Naval College, Greenwich, and Lec-

turer at the Royal Naval War College, etc. New York, The Macmillan Company. $4.50.

This work the author terms a complete text-book on the construction and working of marine engines and boilers, from which it is to be assumed it does not apply to the designing, as the information on the latter subject is quite limited, whereas that on construction—or what follows the design—together with care and management are very complete. He gives a very full history of the development of the steam engine from Savery in 1698 to the turbine and gas producer of to-day. Much information is given to the one wishing to practise the art of designing the different structures, but the most to those desiring to become skilled in the construction, operation and care of the marine engine, as the designing of such machinery demands a line of study outside of what can be given in a treatise of this kind.

The articles on Care and Management are particularly valuable, as they are from the author's experience of many years in charge of machinery in warships of many types in the British Navy. It is, therefore, as he states: "A summary of the best practise of the present day." In support of this let me quote from chapter 32:

> The main propelling machinery is always erected in the workshops before its final erection in the ship. By this system the alignment and proper fitting of all parts are ascertained and any discrepancy remedied while still in the building stage, and usually a water-pressure test is made of cylinder jackets and other fittings in the shop. Although this preliminary building-up of the engines, only to be taken down and rebuilt, seems somewhat of a useless undertaking, experience shows that large saving in the cost of labor and better fitting and adjustment are obtained. . . . The successful working of the machinery is largely dependent upon this accuracy.

The correctness of this view is confirmed by my experience in the same line of work. The double care taken, although seemingly useless and unnecessarily expensive, has been found to be the most economical, also the one from which not only the best results are obtained, but is sure to avoid trouble and disappointment. The amount of care taken is often overdone, but what the author recognizes as necessary can not be avoided if superior results are desired. This part of the book has been dwelt upon as it is one so little recognized in works treating on the steam engine, whereas the neglect to properly inspect and install this engine in the vessel has defeated success from a faultless design. The great trouble in the production of the marine engine has been the absence of the same degree of intelligence in this part of the work, builders and their workmen having too great a tendency to rush the erection in the vessel, notwithstanding the fact that the time and care taken, as well as the first expense incurred are returned a hundred-fold before the vessel leaves the builders' hands, not to say anything in reference to a better performance from the beginning of its life.

Notwithstanding the general excellence of the book, there is one view to which exception must be taken and that is about the combustion chamber in the cylindrical boiler. Here the author states it should not be common to all furnaces, but should be as numerous as the latter in order to produce better circulation so as to save the tube-sheets. This is not only a fallacy as the trouble is due to unnecessarily heavy tube-sheets, but also an evil, as it prevents proper combustion of the gases and tends to produce smoke to obstruct observation and make the presence of the ship known.

This single criticism, however, should not take from the value of the work as it abounds in so much that is good and valuable to one seeking information on the subject and desiring to be correctly informed as to the marine engine practise of to-day and the lines on which it may be extended in the future.

The field of observation and subject covered show how great has been the growth in marine engineering in the past fifty years. In this the author has not been content to treat only on what to-day is found in general service, but invades the realm of the experimenter, taking up the combination of the reciprocating engine with the turbine, as well as the introduc-

tion of the gas producer in combination with the gas engine. The result in the first case will shortly be known as the White Star Line has taken this matter up and is building a large vessel equipped with such engines. The latter subject, however, although one of great interest in view of what has been done with the internal combustion engine, seems to warrant going deeper into the subject and has led up to its consideration on shipboard in connection with supplying gas for the use of the engine. In treating of the gas producer he not only speaks of the good features, but tells of the difficulties, which are of considerable importance, one being the cleaning of the fires and the other the replenishing of the water to produce steam admitted to the fuel when the vessel is in salt water. These are subjects which the enthusiasts on the gas producer have overlooked and will have to be taken care of in its development.

The questions from examination papers at the end of the volume, although some of them are unnecessary, for the proper care and management of the marine engine, such as "Define the term 'the Latent Heat of Steam,'" there are others which will be found valuable such as "Explain how a boiler is liable to suffer from undue haste in raising steam, and describe the precautions that are necessary when steam is being raised." The man who has the care of a steam engine should know all about the management of the boiler and no doubt will attend to his duties much better if his head is not filled with latent ideas.

Horace See

New York,
October 21, 1908

Gray's New Manual of Botany. A Handbook of the Flowering Plants and Ferns of the Central and Northeastern United States and Adjacent Canada, rearranged and extensively revised by Benjamin Lincoln Robinson, Asa Gray Professor of Systematic Botany in Harvard University, and Merritt Lyndon Fernald, Assistant Professor of Botany in Harvard University. New York, Cincinnati, Chicago, American Book Company. Seventh edition, illustrated. Copyright, 1908, by the president and fellows of Harvard College.

Sixty years ago Dr. Asa Gray issued the first edition of his "Manual of the Botany of the Northern United States," which covered the region "from New England to Wisconsin, and south to Ohio and Pennsylvania inclusive." In the second edition (1856) this rather limited region was extended southward so as to include Virginia and Kentucky, and westward to the Mississippi River, and here the boundaries remained for the third, fourth and fifth editions. The sixth edition was nominally "revised and extended westward to the 100th meridian," but in fact did not include all of the plants in the large addition to its area. The westward range of the present edition terminates at the 96th meridian, and it thus includes the trans-Mississippi states of Minnesota, Iowa and Missouri, and small fractions of eastern Nebraska and Kansas.

To one who was "brought up" on Gray's "Manual," this new edition has peculiar interest, and while many changes have been made in the old book the revisers have succeeded in preserving enough of the style of treatment, and the general appearance to make one soon feel at home in the new volume. The first thing that one who knew the old manual notices is the almost complete inversion in the sequence of the families, the book now following Engler and Prantl's "Pflanzenfamilien," instead of De Candolle's "Prodromus." This brings it into harmony with most modern systematic publications in this country and Europe, and makes it much more usable than it would have been had the old sequence been continued.

Another innovation is the introduction of many illustrations (numbering more than a thousand) which help to make the specific descriptions more distinctive. These are usually selected with much care, being used only when they can certainly help the text. Thus in the grasses (*Gramineae*) and sedges (*Cyperaceae*) they are very freely used, as they are also in *Umbelliferae*.

In regard to nomenclature we are told that the editors have scrupulously endeavored to

bring it "into accord with the Vienna agreement." Accordingly the law of priority is observed, and also that requiring the double citation of authorities in certain cases. These, with the acceptance of the year 1753 as the date of the beginning of the binomial nomenclature, and the partial decapitalization of specific names, bring about many changes in the form and appearance of the names of familiar plants, so that sometimes one is not quite sure of the identity of particular species. To help such a situation the authors have judiciously introduced synonyms for certain genera and species.

Although the work is supposed to be rather conservative one notices a surprising number of significant changes in the names of plants. Thus we find *Amaranthus,* instead of *Amarantus; Nymphaea,* instead of *Nuphar; Castalia,* instead of *Nymphaea; Radicula,* instead of *Nasturtium; Gleditsia,* instead of *Gleditschia; Acer saccharam,* instead of *A. saccharinum; Acer saccharinum,* instead of *A. dasycarpum; Acer negundo,* instead of *Negundo aceroides; Psedera,* instead of *Ampelopsis* or *Parthenocissus; Lomatium,* instead of *Peucedanum; Brauneria,* instead of *Echinacea; Agoseris,* instead of *Troximon,* etc. Many minor changes in specific names due to observance of the law of priority may be noticed in glancing through the book; thus we find *Populus deltoides,* instead of *P. monilifera; Carya ovata,* instead of *C. alba; C. illinoensis,* instead of *C. olivaeformis; Fagus grandifolia,* instead of *F. ferruginea; Maclura pomifera,* instead of *M. aurantiaca; Gymnocladus dioica,* instead of *G. canadensis,* etc. That the authors have not been carried away by the flood of new "species" is shown by the fact that they enumerate only sixty-five species of *Crataegus.* They have not been as successful in the genus *Viola* where they admit forty-five species. *Sisyrinchium* is allowed thirteen species, in place of the single species in the first to the fifth edition. Yet we are thankful that the authors have held down the species makers to the extent they have, and we take it as an omen of better things in this regard.

In closing this very general notice of this important addition to the literature of systematic botany we wish to record our opinion that this is the right kind of a revision of such a standard work. It honors the great botanist much more to bring out such a modernized edition than to insist upon retaining the original treatment in all particulars as was done in the ill-starred sixth edition of this manual. The spirit of Dr. Gray was always progressive, and it is right that the successive editions of his books after his death should retain this characteristic, as has been done so well in the volume before us.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

SCIENTIFIC JOURNALS AND ARTICLES

THE concluding (October) number of volume 9 of the *Transactions of the American Mathematical Society* contains the following papers:

G. D. Birkhoff: "Boundary values and expansion problems of ordinary linear differential equations."

A. B. Coble: "An application of the form problems associated with certain Cremona groups to the solution of equations of higher degree."

E. B. Wilson: "On the differential equations of the equilibrium of an inextensible string."

Max Mason and G. A. Bliss: "The properties of curves in space which minimize a definite integral."

Arnold Dresden: "The second derivatives of the extremal integral."

R. L. Moore: "Sets of metrical hypotheses for geometry."

"Notes and errata, volume 9."

THE opening (October) number of volume 15 of the *Bulletin of the American Mathematical Society* contains: "Construction of Plane Curves of given Order and Genus, having Distinct Double Points," by Virgil Snyder; "On Periodic Linear Substitutions whose Coefficients are Integers," by Arthur Ranum; "Even Multiply Perfect Numbers of Five Different Prime Factors," by R. D. Carmichael; "The Fourth International Congress of Mathematicians: Sectional Meetings," by

C. L. E. Moore; "Notes"; "New Publications."

The November number of the *Bulletin* contains: "The Fifteenth Summer Meeting of the American Mathematical Society," by H. E. Slaught; "Answer to a Question raised by Cayley as regards a Property of Abstract Groups," by G. A. Miller; "Note on the Theorem of Generalized Fourier's Constants," by W. D. A. Westfall; "On the Logical Basis of Grassmann's Extensive Algebra," by A. R. Schweitzer; "General Algebraic Solutions in the Logic of Classes," by L. M. Hoskins; "A General Diagrammatic Method of Representing Propositions and Inference in the Logic of Classes," by L. M. Hoskins; "Heinrich Maschke; his Life and Work," by Oskar Bolza; "Notes"; "New Publications."

The American Naturalist for October opens with a paper by F. F. Blackman, on "The Manifestations of the Principles of Chemical Mechanics in the Living Plant." D. D. Whitney describes a number of experiments on "The Desiccation of Rotifers," the conclusions drawn from them being that rotifers do *not* revive after being dried for any length of time, the supposed resuscitation being due to the appearance of those hatched from the winter eggs. O. P. Hay has an article "On the Habits and the Pose of the Sauropodous Dinosaurs, especially of Diplodocus"; he considers that the attitude of these animals was probably like that of a crocodile with the body prone and legs more or less sprawled out, and doubts that they walked erect with legs in an elephantine position. Dr. Hay may not know that crocodiles—some at least—occasionally stand on their hind legs and rush at an assailant. W. A. Setchell gives some "pointers" on "Juvenile Substitutes for Tobacco."

THE *Report of the Commissioners on Fisheries and Game* [for Massachusetts] for 1907 contains much general information and is very interesting reading. We commend it to that writer in *Nature* who recently stated that there was no evidence that the lobster was decreasing! As in the report for 1906 there is much information as to the history and status of the heath hen which there is a possibility of saving from extermination. The cut of the new knockabout type of Gloucester fishing vessel shows how far common sense has overcome the prejudice of sailors against any innovation; while the value of the innovations is shown in the statement that "again we are able to record that not a single Massachusetts fishing vessel has foundered." To appreciate this it is necessary to recall that in the ten years ending in 1883, 82 vessels and 895 men were lost.

PART II. of "The National Collection of Heads and Horns," issued by the New York Zoological Society is mainly devoted to a description of the splendid series gathered by A. S. Reed and presented by Emerson McMillin, another bit of testimony of the liberal manner in which New Yorkers support their scientific institutions. The specimens are from Alaska and British Columbia and comprise some striking examples of the mountain sheep, caribou and giant moose of that region.

INCIDENTAL to the recent meeting of the International Fishery Congress the Bureau of Fisheries has issued an account of its establishment, functions, organization, resources, operations and achievements. This is well illustrated and contains not only information in regard to the work of the Bureau of Fisheries but as to the fisheries of the United States.

MOOREHOUSE'S COMET

PROFESSOR E. B. FROST, director of the Yerkes Observatory, calls attention to the recent increase of brightness of Moorehouse's comet and writes on October 29:

It was visible to the naked eye, and three or four degrees of tail could readily be seen in a small field glass. Three spectrum plates were obtained with the Zeiss ultra-violet doublet and objective prism by Mr. Parkhurst with some assistance from me. Two of these had exposures of one hour. No continuous spectrum was perceptible, whence we may reach the important inference that last night the comet's light was very largely intrinsic. Seven bands were very conspicuous as knots on the plate. I am measuring

the spectra this morning, but have no doubt that they will prove to show the ordinary hydrocarbon spectrum.

. . . .

The photographs taken last night at the Harvard Observatory show a tail at least nine degrees in length, and much longer than on previous nights.

EDWARD C. PICKERING

HARVARD COLLEGE OBSERVATORY,
October 31, 1908

SPECIAL ARTICLES

NOTE ON THE OCCURRENCE OF RHODOCHYTRIUM SPILANTHIDIS LAGERHEIM IN NORTH AMERICA

IN the *Botanical Gazette* for October, 1908,[1] there is published a note on the occurrence of this interesting parasite upon the leaves of the ragweed (*Ambrosia artemisiæfolia*) in North Carolina. This short note is published in the hope that some readers who do not have access to the *Gazette* may have their attention called to this organism and that they may be on the lookout for it in other sections.

The plant is an alga devoid of chlorophyll. It is parasitic on the leaves, stems, pedicels, flower bracts, etc. It begins its development in early summer on the small seedlings and by developing succeeding crops of zoospores continues infection of these same plants throughout the season, until finally the flower racemes are affected. The main body of the parasite forms sporangia which vary from 50 to 300 μ in diameter, the smaller ones being on the leaves. The plant has a reddish-yellow oil deposited in the protoplasm which is so massed in the larger sporangia that it causes a bright red color visible through the thin layer of cortical tissue, so that the plant has the appearance of being studded with minute red dots, suggesting a *Synchytrium*. The plant is always located in or adjacent to the vascular bundles. There is an extensive system of mycelial rhizoids which are profusely branched. These rhizoids extend both up and down. The terminal mycelium is provided with numerous haustoria, many of which are often applied very closely to the spiral ducts, but never entering them, so far as I have observed. The plant body remains connected with the outside wall by the entrance tube. The outer end of these tubes is broadened into a trumpet-like expansion which is the remains of the zoospore wall. The plant thus resembles a giant *Entophlyctis*. The outer end develops into a broad exit tube through which the zoospores escape. The zoospores are biciliated, containing a reddish-yellow oil which is accumulated in the forward end of the elliptical zoospore where the two cilia are attached. Many of the zoospores conjugate in pairs, this taking place during the process of swimming. When the zoospores come to rest, they become rounded and are 8–10 μ in diameter. The zygozoospores are considerably larger.

The resting spores are provided with a very thick wall which is divided into three layers. At maturity there is an abundance of the reddish-yellow oil in the resting spores which is withdrawn along with the protoplasm and starch from the rhizoid system. The rhizoids then become plugged where they join the main body of the sporangium. The inner wall of the resting spores is laid down entirely distinct from the other walls and forms a complete envelop around the content which can be separated distinctly as the endospore from the other walls. The sporangia as well as the rhizoids are provided with starch. Great masses of starch are present in the sporangia. This starch is not, however, manufactured through the photosynthetic process by the organism, but is obtained from the host.

This organism, *Rhodochytrium spilanthidis* Lagerheim[2] was described by Lagerheim[2] fifteen years ago, from material collected on a species of *Spilanthes* in Ecuador. Though Lagerheim searched diligently on other genera he found it occurred only on *Spilanthes*. Here is then an interesting problem of distribution. Collectors in the southern part of

[1] Atkinson, G. F., "A Parasitic Alga, *Rhodochytrium spilanthidis* Lagerheim, in North America," *Bot. Gaz.*, 46, 299–301, 1908.

[2] Lagerheim, G. de, "*Rhodochytrium*, nov. gen., eine Uebergangsform von den Protococcaceen zu den Chytridiaceen," *Bot. Zeit.*, 51, 43–53, pl. 2, 1893.

the United States, Mexico and other tropical and subtropical countries could do an important service by the discovery of this plant. It will be interesting to know whether it is distributed through the intervening region between North Carolina and Ecuador, or whether it is more probable that it has been introduced through the agency of commerce from one country to another. My attention has recently been called to the fact that a form of this plant was distributed in Ellis & Everhart's "Fungi Columbiani" No. 2166 collected on *Asclepias pumila* at Stockton, Kansas, July 18, 1904, by E. Bartholomew and determined by Dr. Farlow as forma *asclepiadis* Farl. The rhizoid system does not seem to be nearly so well developed in this form as in that on the ragweed. This not only shows a greater geographic range, but also an extension to genera outside of the Compositæ. It ought to be found on other hosts. The writer will be pleased to receive specimens from other sections if they are found.

The plant was discovered in North Carolina by Dr. F. L. Stevens. Since the note was written for the *Gazette*, Dr. Stevens has given additional notes on the occurrence of the plant. The first collection was made in August, 1903, at West Raleigh. It occurs there every year in great abundance. In many cases the ragweed is so affected that the distortion can be recognized from the car windows. The stems and leaves affected are more or less stunted, twisted and curled. Rarely the affected areas on the stems may be slightly greater in diameter.

Other locations in North Carolina, with dates on which it has been collected by Professor Stevens, are given herewith.

1. Polkton	August	1, 1908.
2. Clayton	"	2, 1908.
3. Carey	"	5, 1908.
4. McLeansburg	"	7, 1908.
5. Davidson	"	13, 1908.
6. Mt. Ulla	"	15, 1908.
7. Hiddenite	"	17, 1908.
8. Taylorsville	"	18, 1908.
9. Connelly Springs	"	20, 1908.
10. Connelly Springs	"	21, 1908.
11. Marion	"	21, 1908.
12. Rutherfordton	August	22, 1908.
13. Hendersonville	"	25, 1908.
14. Auburn	"	27, 1908.

Geo. F. Atkinson

THE PRESENT STATE OF OUR KNOWLEDGE OF THE ODONATA OF MEXICO AND CENTRAL AMERICA

The completion of the account[1] of the Odonata in the *Biologia Centrali-Americana* and the rather restricted circulation which the book must enjoy, owing to the necessarily expensive character of this series,[2] will perhaps justify the publication in Science of a summary of the main results obtained, and of a comparison with previous work done in this field.

The preparation of this volume successively undertaken by McLachlan, of London; Hagen, of Cambridge, Mass., and Karsch, of Berlin, and successively relinquished by each of them under the pressure of ill-health or of other work, was entrusted to the present writer in the beginning of 1899.

The material on which it is based was primarily that acquired for the purpose by Dr. Godman, editor of the *Biologia*, and his associate, the late Osbert Salvin, F.R.S., but thanks to the directors, curators and owners of public and private museums, a still larger series of specimens has been available. It is, therefore, a great pleasure to acknowledge the aid thus rendered by the Academy of Natural Sciences of Philadelphia, the United States National Museum, the Museum of Comparative Zoology, the American Museum of Natural History, the Carnegie Museum of Pittsburg, the California Academy of Sciences, the Field Columbian Museum, the late Robert McLachlan, F.R.S., and Messrs. E. B. Williamson, C. C. Adams, C. C. Deam, J. G. Needham, H. Kahl, O. S. Westcott and E. A. Smyth, Jr.

[1] "Odonata," by Philip P. Calvert, forming pages 17–420, v–xxx, plates II.–X., 1 map, of volume Neuroptera, *Biologia Centrali-Americana*. Edited by F. Ducane Godman, F.R.S., etc., London, 1901–8, 4to.

[2] A sketch of the *Biologia* was published in *Entomological News*, XVI., pp. 317–322, December, 1905.

These collections contain the fruits of the field labors in Mexico, Central America and adjacent territory, both north and south, of Messrs. A. Agassiz, A. Alfaro, C. F. Baker, H. S. Barber, O. W. Barrett, J. H. Batty, Dr. Berlandier, P. Biolley, F. Blancaneaux, A. Boucard, L. Bruner, Burgdorf, H. K. Burrison, P. P. Calvert, Merritt Cary, G. C. Champion, Chaves, L. J. Cole, O. F. Cook, Collins, Lieutenant Couch, J. C. Crawford, Jr., G. R. Crotch, C. C. Deam, F. Deppe, C. H. Dolby-Tyler, Dubosc, A. Dugès, G. Eisen, H. J. Elwes, Festa, A. Forrer, H. Frühstorfer, G. F. Gaumer, F. D. Godman, P. H. Goldsmith, R. F. Griggs, the Hassler Expedition, R. H. Hay, B. Hepburn, Professor A. Heilprin (Expedition of the Academy of Natural Sciences, Philadelphia), Heyde, J. S. Hine, M. E. Hoag, C. F. Hoege, L. O. Howard, H. N. Howland, E. Janson, M. Kerr, C. H. Lankester, F. L. Lewton, F. E. Lutz, G. F. Mathew, W. M. Maxon, J. F. McClendon, R. E. B. McKenney, McNeill, N. Miller, A. B. Nichols, Palmer, H. Pittier, Ribbe, W. Richardson, C. W. Richmond, S. N. Rhoads, G. O. Rogers, H. Rogers, O. Salvin, H. de Saussure, W. Schaus, Schild, Schumann, S. C. Schumo, Shakspear, H. H. Smith, F. E. Sumichrast, O. Thieme, W. L. Tower, C. H. Townsend, J. F. Tristan, M. Trujillo, C. A. Uhde, C. F. Underwood, F. H. Vaslit, W. H. Vogel, C. Werckele, O. S. Westcott, C. H. White, E. B. and L. A. Williamson, H. Wilson and Mrs. E. B. Williamson.

In consonance with the general plan of the *Biologia* the work deals chiefly with the geographical distribution and taxonomy of these insects in Mexico and Central America, but includes their extra-limital occurrence also. The advance in knowledge which is here recorded can be seen from a comparison with the three older works which attempted completeness at their respective periods. (1) The "Synopsis of the Neuroptera of North America," by Hermann Hagen, published by the Smithsonian Institution in 1861; (2) the same author's "Synopsis of the Odonata of America" in the *Proceedings of the Boston Society of Natural History,* volume XVIII., 1875, which, as it omits the Lestinæ and Agrioninæ, must be supplemented for these subfamilies by the synopses of Baron Edmond de Selys Longchamps in the *Bulletins de l'Academie Royale des Sciences de Belgique,* 1865–77; and (3) the "Catalogue of Neuroptera Odonata" [of the world], by Mr. W. F. Kirby, London, 1890. This comparison is set forth in the following tables:

TABLE I.

Showing the Increase in the Number of Species and of Localities

Author	Number of Species		No. of Localities quoted from						
	Mexico	Cen. Amer.	Mexico	B. Hon. & Yucatan	Guatemala	Honduras	Nicaragua	Costa Rica	Panama
Hagen, 1861	69	4	10	(1)	(1)	(1)	0	0	0
Hagen, 1875, and Selys, 1861–77	88	26	15	(1)	(1)	(1)	1	0	1
Kirby, 1890	89	38							
Calvert, 1901–8	219	208	144	10	55	5	7	31	13

TABLE II.

Showing the Increase in the Number of Records

Author	Number of Records[3]						
	Mexico	B. Hon. & Yucatan	Guatemala	Honduras	Nicaragua	Costa Rica	Panama
Hagen, 1861	77	1	2	4	0	0	0
Hagen, 1875, and Selys, 1862–77	120	1	10	4	1	0	15
Calvert, 1901–8	1215	27	508	66	25	237	125

After deducting the duplications, the total number of species now known for Mexico and Central America as a whole is 293, of genera 71.

Only five of the species recorded by previous authors have not been seen by the writer—*Paraphlebia hyalina, Argia orichalcea, Herpetogomphus boa, Herpet. menetriesii* and *Macromia* sp., the last known only in the

[3] A "record" for any species is the noting of its occurrence in any one locality, and for each species there are as many records as there are separate localities at which it has been found.

nymphal stage. Two species, *Argia calida* Hagen and *A. funebris* Hagen, are known only from the type specimens.

Synoptic keys are given to the genera of the six sub-families comprising more than one genus each and to the species of forty-five of the genera. Two genera (*Hesperagrion* and *Metaleptobasis*—both Agrioninæ) and eighty-one species have been described as new.

Except in these eighty-one species and in the genus *Argia*, the specific descriptions and the figures on the plates are limited to features unnoticed, or insufficiently or incorrectly described or figured in the previous literature, which it is believed has been cited very fully. The distribution of each species is given in detail; the number and sex of the specimens examined and the collector's name are stated after each locality. To give the fullest information on such topics, the first of the two tables in the introduction comprises an alphabetically-arranged list, by countries, of all the localities from which Odonata are represented, the state, altitude and temperature-zone of each locality, the date of collection, the collector's name, and often remarks on the physical character of the environment or the precise spot where the insects were gathered.

The greater part of the nine years occupied in the preparation of this work has been consumed by the gathering and tabulating of various characters—especially those of the veining of the wings—which have been employed by previous writers to separate the genera, or which seemed to lend themselves to that purpose. These data (collected without the aid of clerks or assistants), numbering above one hundred and fifty thousand, were reduced to percentages for each of the species studied. Features which showed a variation of ten per cent. or less were thereby assumed to be of sufficient constancy to serve as generic characters, and among these importance was naturally assigned to those showing the least degree of variability. Many of the specific, as well as the generic, characters employed in the work rest on a similar basis. At the same time it must be remarked that the data are not sufficiently numerous for any one species to furnish bases for mathematical formulæ. The limitations of time and strength and in many cases also the available material forbade the examination of more than twenty-five or thirty individuals of a species, but not infrequently these were tabulated for twenty-five different characters, which in the case of the wind-details were noted for both sides of the body in each specimen. Further statement of this part of the work is not made here nor is it more than hinted at in a large part of the *Biologia* volume itself, since it is hoped to publish in another place tables of the percentages obtained.

Under each species, where possible, special attention has been given to noting: (1) the color changes through which the imago passes from the time of transformation to the final tints of old age—which has been done for fifty-two species, the most extensive changes being perhaps those of *Hesperagrion heterodoxum* (pp. 103, 377 and Plate VI., Figs. 1–6); (2) the geographical variations; (3) the individual variations found in the same locality. Owing to the conservative attitude adopted towards species, many of these variations (2) and (3) will doubtless afford—indeed have already afforded in one case—additional "species" to later workers in this field, but in these days one may perhaps reply to criticism with *de speciebus dividendis non disputandum*. In the matter of nomenclature some use has been made of trinomials, in the sense of the American Ornithologists' Union.

The areas which have been most carefully examined are portions of the Mexican states or territories of Tepic, Jalisco, Guerrero, Morelos, Distrito Federal, Tamaulipas, Vera Cruz and Tabasco, the central belt of Guatemala from the Caribbean to the Pacific and a few localities in Costa Rica. The odonatologically unknown area in Mexico and Central America is, therefore much greater than that which has been investigated.

Of the physical data which have yet been brought together, only those on temperature are sufficiently complete to enable one to make a natural division of Mexico and Central America as a whole, with which the distribu-

tion of the Odonata can be compared. A new map showing the mean annual temperatures of these countries has been compiled on the basis of previous maps and more recent records of meteorological observatories, and is included in the volume. Classifying these temperatures into groups of 5° C. each, there are obtained five (or six?) zones whose mean annual temperatures range from 30° (or more?) C. to less than 10° C. The second table in the introduction, a systematic list of the species, gives their distribution, *inter alia,* by temperature-zones. Incidentally it may be mentioned that the zone of 25°–20° C. has yielded the greatest number of species of dragonflies and the greatest number of endemic species.

As may be gathered from the foregoing, the ecological relations of these insects have not been fully treated in the *Biologia,* but many data have been brought together in a separate paper[4] dealing with the composition of this Odonate fauna and its relations to temperature, rainfall, forest areas and other environmental factors. Two ecological topics, however, are incidentally referred to in the *Biologia* volume but not in the ecological paper: Mimicry and the Proportions of the Sexes.

The examples of mimicry indicated are: *Paraphlebia* and *Palæmnema* (page 133, footnote ‡); *Libellula saturata croceipennis, Orthemis ferruginea, Libellula foliata* and *Paltothemis lineatipes* (pp. 212, 292); *Dythemis cannacrioides* and *Cannacria* species (p. 277); *Rhodopygia hollandi* and *Erythemis hæmatogastra* (pp. 319, 338); *Platyplax sanguiniventris* and *Erythemis peruviana* (pp. 328, 334). In none of these cases, however, is there as yet any evidence for or against the protective value of these resemblances.

Proportions of the Sexes.—10,838 specimens have been cited in this work from Mexico and Central America and 2,746 of the same species from other countries. Of the 10,838, 7,165 are males, 3,673 are females. That these numbers can not be regarded as having any special significance may be seen from the following comparisons:

A. Forms with dissimilarly colored wings in the two sexes, males the more conspicuous: *Hetærina cruentata* 265 ♂, 91 ♀; *H. vulnerata* 43 ♂, 44 ♀; *H. macropus* 239 ♂, 81 ♀; *H. infecta* 27 ♂, 27 ♀.

B. Forms with uncolored wings, bodies dissimilarly colored in the two sexes: *Argia extranea* 236 ♂, 160 ♀; *A. pulla* 414 ♂, 53 ♀; *A. lacrymans* 7 ♂, 7 ♀; *Ischnura ramburi* 18 ♂, 27 ♀; *I. denticollis* 140 ♂, 143 ♀; *I. demorsa* 44 ♂, 57 ♀; *Orthemis ferruginea* 196 ♂, 76 ♀; *O. levis* 28 ♂, 28 ♀.

C. Forms with similarly colored wings and bodies: *Megaloprepus cœrulatus* 42 ♂, 32 ♀; *Mecistogaster ornatus* 49 ♂, 73 ♀.

It is more likely that these numbers are due to the accidents of collecting than that they represent the proportions of nature.

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[4] "The Composition and Ecological Relations of the Odonate Fauna of Mexico and Central America," by Philip P. Calvert. To appear in the *Proc. Acad. Nat. Sci. Philadelphia* for 1908.

SOME INVERSIONS OF TEMPERATURES IN COLORADO

As a part of some botanical work being done on the hills south of Boulder, Colo., two thermographs were kept running during the spring of 1908. One of these was located on the campus of the University of Colorado, at an altitude of 5,420 feet, the other on a mesa (flat-topped hill) about three quarters of a mile to the south, and at an altitude of 5,835 feet. The station on the mesa is about one mile east of the face of Green Mountain, which rises abruptly 3,000 feet.

As is well known, a mean difference of three degrees Fahrenheit usually occurs for each 1,000 feet in mountain districts, the higher points being the colder. Unless "inversion" occurs the records of the mesa would be expected to show about one or two degrees colder than the university campus. The observations show that inversion does occur and that the night temperatures on the mesa are distinctly higher than on the university campus. For the present note it will be sufficient to give certain data for the month of May.

TEMPERATURES OF CAMPUS AND MESA, MAY, 1908

	Campus, 5,420 ft.	Messa, 5,835 ft.
Monthly mean	51.5	54.1
Mean maximum	60.5	61.0
Mean daily range	23.2	19.5
Greatest daily range	39.0	36.0
Least daily range	0.0	2.0
Number of days having minimum 32 degrees or lower	5.0	2.0
Date of latest frost	May 21	May 5

For the table above the monthly mean was calculated by averaging the daily means obtained by the formula

(7 A.M. + 2 P.M. + 9 P.M. + 9 P.M.) ÷ 4 = *mean*.[1]

The mean temperature of the mesa station was 2.6 degrees higher than that of the campus; the mean maximum 0.5 degrees and the mean minimum 3.4 degrees higher. It will be noted that the greatest difference is in the mean minimum. The mean daily range is conspicuously less for the mesa than for the campus. To state the case briefly the mesa station has a milder climate than that of the campus; the daily range is less, the mean temperature greater; also for the present year, at least, killing frosts did not continue so late in the season.

The month of April was warmer than May, but in spite of this anomaly there were about the same differences between campus and mesa. An important point to notice, however, is that the mean maximum was higher at the campus station, 63.8 as against 61.6 on the mesa, but the mean minima show about the same differences as recorded for May. In April, therefore, the campus showed a much more severe climate than the mesa. Days were hotter, nights were cooler.

Hann states (p. 252) that "in calm weather the valleys are colder than the enclosing mountains, up to a certain height." In the observations made by the writer there was this difference, not only in calm weather but also in windy weather, indeed, nearly every night the mesa station showed the higher temperature.

Since the university campus is on the plains, while the mesa is part of the lower foothills, it may be said that the plains have a more severe climate than the lower foothills. The writer believes that this difference in climate is an important one in determining the limits of distribution of plants at the tension line between foothills and plains. This question will be discussed at length in an article soon to be published in the University of Colorado Studies by the present writer and Messrs. G. S. Dodds and W. W. Robbins.

[1] Hann, "Handbook of Climatology," Ward's translation, 1903, p. 7.

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SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

THE fall meeting of the Physical Society was held at Columbia University, New York City, on Saturday, October 24, 1908, with President Edw. L. Nichols in the chair.

The following papers were presented:

"Note on Spherical Aberration," W. S. Franklin.

"New Photometric Methods of Studying the Radiating Properties of Various Substances," Edward P. Hyde.

"Sparking Potentials in a Very High Vacuum," R. A. Millikan.

"Non-Newtonian Mechanics," Gilbert N. Lewis.

"The Definition of a Perfect Gas," A. G. Webster and M. A. Rosanoff.

"The Specific Heats of Gases and the Partition of Energy," W. P. Boynton. (By title.)

"The Distribution of Sound from the Megaphone," A. G. Webster.

"The Reflection of Sound by the Ground," A. G. Webster.

"Thermometric Lag in Calorimetry," Walter P. White. (By title.)

"The Electromagnetic Mass of a General Electric System," D. F. Comstock.

"A Study of Electric Wave Vibrators and Receivers," H. W. Webb.

"Note on a Method of Determining the Concentration of the Free Electrons in a Metal," O. W. Richardson.

"The Kinetic Energy of the Positive Ions emitted by Hot Bodies," F. C. Brown.

The next meeting of the society will be at Chicago on the Friday and Saturday following Thanksgiving.

ERNEST MERRITT,
Secretary